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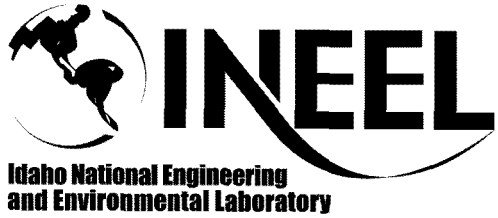
Effective Date: 8/23/04

Construction Specification

PROJECT NO. 22901

TSF-09/18 VTanks Remediation

Approved for Construction



Idaho National Engineering
and Environmental Laboratory

Form 412.14
10/9/2003
Rev. 05

412.15
10/31/2002
Rev. 04

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DOCUMENT APPROVAL SHEET

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SIGNATURES

6. Type or Printed Name / Signature	7. Signature Code	7. Date	8. Organization/ Discipline
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R F Lippert			Structural Engineer

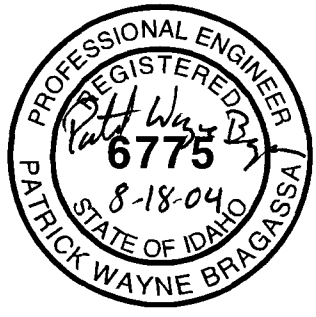
9. Document Control Release Signature: Jenna Mann Ostler Date: 8/20/04

RECORDS MANAGEMENT

10. Is this a Construction Specification? Yes ☒ No ☐ 11. NCR Related? Yes ☐ No ☒
12. Does document contain sensitive, unclassified information? ☐ Yes ☒ No If Yes, what category: _____
13. Can document be externally distributed? Yes ☒ No ☐
14. Area Index Code: Area _____ Type _____ SSC ID _____
15. Uniform File Code: 0250 16. Disposition Authority: ENV-1-b-4 Record Retention Period: Cutoff when superseded, obsolete or canceled. Destroy 75 years after cutoff.
17. For QA Records Classification Only: Lifetime ☐, Nonpermanent ☐, Permanent ☐
Item or activity to which the QA Records apply: _____
18. Periodic Review Frequency: N/A ☒, 5 years ☐, or Other _____

TSF-09/18 VTanks Remediation

The following Sections of this Specification were prepared under the direction of the Registered Professional Engineer as indicated by the seal and signature provided on this page. The Professional Engineer is registered in the State of Idaho to practice Civil Engineering.



Division 1 -- General Requirements

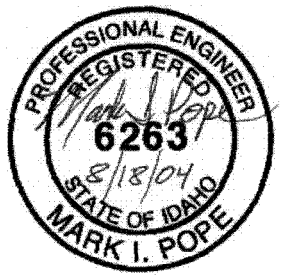
01005 -- Summary of Work
01300 -- Submittals

Division 2 -- Site Work

02140 -- Temporary Diversion and Control of Water During Construction
02200 -- Earthwork

TSF-09/18 VTanks Remediation

The following Sections of this Specification were prepared under the direction of the Registered Professional Engineer as indicated by the seal and signature provided on this page. The Professional Engineer is registered in the State of Idaho to practice Mechanical Engineering.



Division 13 -- Special Construction

13207 -- Tanks

Division 15 -- Mechanical

15024 -- Pressure Piping/Vessel Welding
15203 -- Process Piping (ASME B31.3 Category M)
15800 -- Heating System

TSF-09/18 VTanks Remediation

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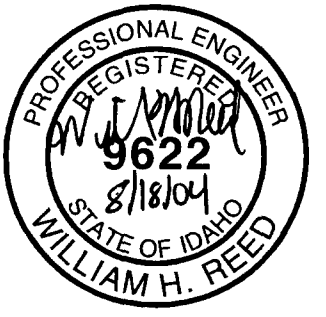
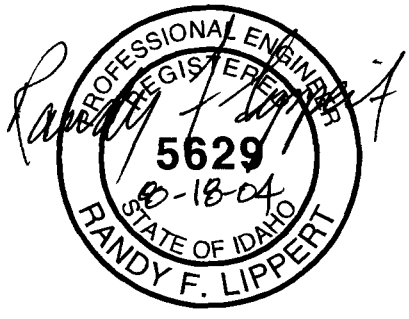


Division 16 -- Electrical

16000 -- Electrical General Provisions
16109 -- Switches, Receptacles and Wall Plates
16120 -- Cable, Wire, Connectors and Miscellaneous Devices
16124 -- Insulated Medium Voltage Cable and Connectors
16155 -- Motor Starters (<600VAC)
16160 -- Panelboards
16195 -- Electrical Identification
16414 -- Medium and High Voltage Pole Hardware and Equipment
16450 -- Grounding
16462 -- Transformers, Pad Mounted, Liquid Filled, Power
16810 -- Instrumentation

TSF-09/18 VTanks Remediation

The following Sections of this Specification were prepared under the direction of the Registered Professional Engineer as indicated by the seal and signature provided on this page. The Professional Engineer is registered in the State of Idaho to practice Structural Engineering.



Division 5 -- Metals

05100 -- Structural Steel and Miscellaneous Metals

Electrical work includes but not limited to:

Furnish and installation of new permanent and temporary electrical power as indicated on the drawings

Furnish as indicated portable power centers raceways, fittings, boxes, plugs, receptacles, panel breakers, wire, cords and cables as indicated on the drawings

Furnish and installation of electrical level instrumentation as indicated on the drawings

Furnish and install electrical line work, poles 53-13-4 through 4-B

Furnish and install electrical transformer, 750 KVA and related wiring and hardware

Settings and calibrations of all instruments, circuit breakers and purchase of and installation of motor overload heaters

Furnish and install any temporary lighting that may be required during project

Quality control tests and documents and indicated in the attached specifications.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C-2 National Electrical Safety Code (NESC)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA-70 National Electrical Code (NEC)

FACTORY MUTUAL

NATIONAL RECOGNIZED TESTING LABORATORIES (NRTL)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

CANADIAN STANDARDS ASSOCIATION (CSA)

UNDERWRITERS' LABORATORIES, INC. (UL)

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 OSHA Occupational Safety and Health Standards
29 CFR 1926 OSHA Health and Safety Standards for Construction

BECHTEL BWXT IDAHO, LLC (BBWI)

Subcontractor Requirements Manual

Unless otherwise specified, references in these specifications or on the subcontract drawings to other specifications, codes, standards or manuals that are part of these specifications, but not included herein, shall be the latest edition, including any amendments and revisions, in effect as of the date of this Specification.

QUALITY ASSURANCE:

Quality Assurance Program requirements shall exist to assure that work performed is in conformance with the requirements established by the drawings and this specification. QA Program criteria applicable to this scope of work is addressed in the Special Conditions, BBWI Subcontractor Requirements Manual, General Provisions, and these specifications.

Standard Products: The materials and equipment furnished by the Subcontractor shall be standard products of manufacturers regularly engaged in the production of the type of materials and equipment required and shall be of the manufacturer's latest standard designs. Where two or more units of the same type and class of material or equipment are required, the units shall be the product of the same manufacturer, and shall be identical insofar as possible. The component parts of a unit of equipment need not be the products of the manufacturer.

SAFETY, HEALTH AND ENVIRONMENT:

In general work shall be in compliance with the applicable sections of 29 CFR 1910, 29 CFR 1926 and the BBWI Subcontractor Requirements Manual.

DELIVERY, STORAGE AND HANDLING:

All materials normally packaged shall be delivered to the site in the original, unopened packages with labels intact. Upon arrival, the Subcontractor shall inspect the materials or equipment for damage.

Materials and equipment shall be stored and handled in accordance with the manufacturer's instructions. Protect construction materials, equipment, flange facings, threads, machined or painted, and other exposed finished surfaces from damage.

PART 2--PRODUCTS

MATERIALS:

New Materials and Equipment: Materials and equipment received by the Subcontractor in a damaged condition shall be repaired or replaced by the Subcontractor as directed by the Contractor. Materials and equipment damaged by the Subcontractor shall be repaired or replaced by the Subcontractor.

Approved Equal: Whenever a product is specified by using a proprietary name, the name of a manufacturer, or vendor, the specific item mentioned shall be understood as establishing type, function, dimension, and quality desired. Other manufacturer's products will be accepted, provided sufficient information is submitted to determine that products proposed are equivalent to those named.

Existing Materials, Equipment and Structures: Existing materials, equipment and structures, including paint and protective coatings, involved under this Subcontract shall be thoroughly inspected by the Subcontractor before starting any work. Any defects or damages, the repair of which are not covered under these specifications or subcontract drawings, shall be reported in writing to the Contractor by the Subcontractor. The Subcontractor shall place reinstalled operating equipment in an operating condition that is at least as good as it was at the time the Subcontractor started work.

Hazardous Chemicals and Substances: The Subcontractor shall comply with applicable requirements of 29 CFR 1926.59, Hazard Communication Standard.

PART 3--EXECUTION

CONSTRUCTION AND INSTALLATION:

General: Materials and equipment shall be erected or installed only by qualified personnel who are regularly engaged in the trades required to complete the work. The subcontract drawings show the general arrangement and space allocation of the equipment specified. It shall be the Subcontractor's responsibility to verify changes in conditions or rearrangements necessary because of substitutions for specified materials or equipment. Where rearrangements are necessary the Subcontractor shall, before construction or installation, prepare and submit drawings of the proposed rearrangement for approval.

Coordination of Work: Where new work and existing facilities are shown on the drawings, but are not located precisely by dimensions, the Subcontractor shall be responsible for proper location and clearances and for correcting discrepancies and interferences in the work that are a result of his operations. Work done by one trade that must be integrated with work of

other trades shall be laid out with due regard to the work done, or to be done, by other trades; particularly if the work done by one trade depends upon completion or proper installation of work done by other trades. The Subcontractor shall cooperate in coordinating his work with work being done by others if their work must be integrated with the Subcontractor's work. The Subcontractor shall notify the Contractor at least one week prior to the date on which the Subcontractor proposes to proceed with the work.

Workmanship: Work shall be done in a skillful and workmanlike manner. The Subcontractor shall do structural cutting, fitting, patching, repairing and associated work necessary for installation of equipment, piping and electrical conduits, etc. No major cuts or holes, not shown on the drawings, shall be made without prior approval of the Contractor. After the equipment and/or piping is installed, exposed holes, cracks and other defects shall be neatly patched and the patched areas shall match the adjoining materials and finish.

REPAIR AND RESTORATION:

Materials and equipment repaired or replaced by the Subcontractor shall be subject to acceptance by the Contractor.

PROTECTION:

Construction materials, equipment, flange facings, threads, machined or painted, and other exposed finished surfaces shall be protected from damage during construction.

END OF SECTION 01005

SECTION 01300--SUBMITTALS

PART 1--GENERAL

SUMMARY:

This section specifies the administrative, technical and quality requirements for vendor data submittals. Vendor data requirements are specified in individual specification sections or on the drawings, and tabularized on a Vendor Data Schedule. In the event of conflicting requirements, the submittal requirements prescribed in the individual specification section shall take top priority, the drawings second and the vendor data schedule last.

The Subcontractor shall submit data, drawings, and other submittals specified. If the Contractor determines the Subcontractor's submittal to be incomplete or unacceptable, the Subcontractor shall make a complete and acceptable submittal to the Contractor by the second submission of a submittal item.

The Subcontractor shall be responsible for providing submittals in accordance with the Subcontract General Provisions Document, providing submittals with adequate time for review and resubmittal, and advising the Contractor of any submittal that may be delayed and which might, if further delayed, extend completion of the project.

Section Includes, but is not limited to:

> The preparation, transmittal and delivery of documents by the Subcontractor to the Contractor as required in the "Submittals" subdivision of the specification sections and as provided on the Vendor Data Schedule.

Related Sections: General Provisions, Subcontractor Requirements Manual, Special Conditions, Drawings, Vendor Data Schedule, and other sections of these specifications apply to this section.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.1 Drawing Sheet Size and Format

SUBMITTALS:

General Procedures: Vendor data, whether prepared by the Subcontractor or Subcontractor's subtier or supplier, shall be submitted as instruments of the Subcontractor. Therefore, prior to submittal, the Subcontractor shall ascertain that material and equipment covered by the

submittal and the contents of the submittal itself, meet all the requirements of the subcontract specifications, drawings, or other contract documents.

Each submittal shall contain identification for each separable and separate piece of material or equipment, and literature with respect to the information provided in the specification and on the Vendor Data Schedule. Submittals shall be numbered consecutively for each different submittal.

Vendor Data Schedule: Vendor data required by the specification sections or the drawings to support design, construction, and operation of the project is identified on a Vendor Data Schedule. The Vendor Data Schedule provides a tabular listing by item number, drawing or specification reference, and description of the item or service. The type of submittal is identified by a "Vendor Data Code," and the time required to submit the item is identified by a "When to Submit" code. An "Approval" code specifies whether the submittal is for Mandatory Approval or for Information Only. One copy of routine paper or electronic file submittals are required; additional copies may be required by the Vendor Data Schedule. Electronic file submittals are preferred. Submittals that cannot be scanned or provided electronically, such as large shop drawings, will require 6 copies for Mandatory Approval and 4 copies for Information Only. Material or color samples will require 2 sets for Mandatory Approval and 1 set for Information Only.

Or Equal Material or Equipment Submittals: All "or equal" materials, equipment or systems shall be identified and submitted for approval as required by the Subcontractor Requirements Manual.

An "or equal" submittal shall contain as a minimum all operating and physical parameters necessary to show that the material or equipment is equivalent to the specified material or equipment. All parameters shall be specifically identified by the submitter in the proposal. Exceptions or differences between the specified item and the "or equal" item shall also be identified.

If an "or equal" material, equipment or system is approved, the Subcontractor shall be responsible for backup material necessary to include the material, equipment or system in the technical documents. In most cases this includes "red lining" a set of design drawings, and specifications to provide an "Approved for Construction" set of specifications and design drawings which incorporate the changes caused by the "or equal" item. These "red line" drawings shall be submitted prior to use of the "or equal" item. Any calculations or other backup material necessary to show that changes are adequate shall be included with the "red line" drawings and specifications.

Vendor Data Transmittal and Disposition Form 431.13: All vendor data shall be submitted to the Contractor using the Vendor Data Transmittal and Disposition Form. The form provides the Subcontractor a method to submit vendor data and provides the Contractor a means of dispositioning the submittal. The Subcontractor shall list the Vendor Data Schedule item number, a Vendor Data Transmittal tracking number (if applicable), the drawing or specification number reference, a Tag Number (if applicable), the submittal status

(e.g., Mandatory Approval, Information Only, Re-submittal, or Or-equal), the Revision Level, and the item description. The description should include the heat or lot number for items requiring Certified Mill Test Reports. The description should be complete enough that a person unfamiliar with the project can determine what the submittal includes.

Disposition by the Contractor: The Contractor's comments and required action by the Subcontractor will be indicated by a disposition code on the submittal. The disposition codes will be classed as follows:

(A) "Work May Proceed." Submittals so noted will generally be classed as data that appears to be satisfactory without corrections.

(B) "Work May Proceed with Comments Incorporated. Revise Affected Sections and Resubmit Entire Submittal." This category will cover data that, with the correction of comments noted or marked on the submittal, appear to be satisfactory and require no further review by the Contractor prior to construction.

(C) "Work May NOT Proceed. Revise and Resubmit." Submittals so dispositioned will require a corrected resubmittal for one of the following reasons:

1) Submittal requires corrections, per comments, prior to final review
2) Submittal data incomplete and requires more detailed information prior to final review
3) Submittal data does not meet Subcontract document requirements.

(D) "Accepted for Use. Information Only Submittal." Submittals so dispositioned will generally be classified as Information Only for as-specified material and equipment.

Mandatory Approval coded vendor data will be reviewed by the Contractor and receive an A, B, or C disposition. The Contractor may provide internal review of Information Only submittals. In the event that comments are generated on an Information Only submittal, the submittal may be dispositioned B or C and returned to the Subcontractor for appropriate action. Information Only submittals without comments will receive a D disposition.

All submittals will be returned to the Subcontractor. Acknowledgment of receipt of dispositioned vendor data by the Subcontractor will not be required.

The Contractor will return dispositioned submittals with reasonable promptness. The Subcontractor shall note that a prompt review is dependent on timely and complete submittals in strict accordance with these instructions.

PART 2--PRODUCTS (SUBMITTAL REQUIREMENTS)

CERTIFIED MILL TEST REPORTS:

Where specifically required by other sections, certified mill test reports (CMTRs) shall be provided. The CMTRs shall be issued from the manufacturer who actively produces the item(s) and/or material to which the CMTR applies or a certified test laboratory. Each CMTR shall include the following:

1. Applicable codes and standards (such as ASTM or ASME) for the item(s) and/or material to which the CMTR applies
2. General description of the item(s) and/or material to which the CMTR applies
3. Heat or lot number of the item(s) and/or material to which the CMTR applies
4. Actual chemical composition and the physical characteristics of the item(s) and/or material to which the CMTR applies. The physical characteristics noted shall include ultimate tensile strength, yield strength and elongation as a minimum. Reporting of physical characteristics is not required in the case of weld filler material unless otherwise noted in the applicable specification subdivision
5. Signature and organizational title of the individual authorized to certify the accuracy of the data indicated on the CMTR for the item(s) and/or material shown.

EQUIPMENT DATA:

Where specifically required by other sections, equipment data shall be provided. As applicable and except as otherwise specified, equipment data shall include the manufacturer's name and address, the model number, and specific information on performance, operating curves and data, ratings, capacities, characteristic efficiencies, catalog data, equipment dimensions, evidence of compliance with safety and performance standards, and other data required to fully describe the equipment. Data shall be submitted in sets covering complete systems or functioning units. The data shall also be identified with the tag number of the equipment or device for which the data applies.

INSPECTION AND TEST PROCEDURES:

Where specifically required by other sections, inspection and test procedures shall be provided. Inspection and test procedures shall include, as applicable: description of item or items involved, inspection or testing to be performed, a listing of testing agency and technical personnel to be used, description of equipment and facilities to be used, test prerequisites, test methods, test evaluation and acceptance criteria, safety precautions, sign-off requirements, methods for control and calibration of measuring and test equipment, proposed test record form, references to applicable portions of the subcontract documents, and detailed procedures, methods, and criteria for evaluation and acceptance. Test procedures shall be prepared in accordance with the Subcontract Requirements Manual, PRD-5014 “Test Control.”

INSPECTION AND TEST REPORTS:

Where specifically required by other sections, inspection and test reports shall be provided within 10 working days of such inspection or test. Inspection and test reports shall include, as applicable: identification of material or item inspected, inspection data, functional test data, date(s) and place(s) of inspection/tests, names of agencies and technicians involved, references to procedures and methods used, references to applicable portions of the subcontract documents, names of persons evaluating test results, identification of work failing to meet inspection/test acceptance criteria, and detailed description of corrective action taken. Test reports shall be provided in accordance with the Subcontract Requirements Manual, PRD-5014 "Test Control."

INSTALLATION, APPLICATION, AND ERECTION INSTRUCTIONS:

Installation, application, and erection instructions shall be provided where specifically required by other sections. Installation, application, and erection instructions shall be clear, concise, and detailed, and shall utilize drawings and pictures to the extent necessary. The instructions shall include procedures for delivery acceptance, unpacking, inspection, re-packing, storage, handling, preparation of supporting work, assembly, and incorporation of the material/equipment into the work. The instructions shall include sequences, precautions, and tolerances.

In general, the Contractor's Representative will inspect the work to the criteria and instructions prescribed in the manufacturer's installation, application and erection instructions. The Subcontractor shall not deviate from the written instructions without prior written approval and direction from the manufacturer; such approval and direction shall be submitted to the Contractor as an attachment to the manufacturer's installation, application and erection instructions.

MATERIAL AND EQUIPMENT LISTS:

Where specifically required by other subdivisions, material and equipment lists shall be provided. Material and equipment lists shall be complete for the work specified under the subdivision and shall include all materials, products, equipment, and fixtures, including consumables. Lists shall include manufacturer's name and address, trade or brand name, local supplier's name and address, unit quantities, and catalog numbers required to fully describe the item.

OPERATION AND MAINTENANCE (O&M) MANUALS:

Where specifically required by other sections, operation and maintenance manuals shall be provided.

Contents: O&M manuals for manufacturer's standard items shall, unless otherwise specified, be the standard publication issued for the product by the manufacturer.

O&M manual for special engineered items or systems shall, as a minimum, contain the following information when applicable, unless the information is requested and submitted separately:

1. Cover sheet identifying the project, site, Contractor, Subcontractor and identification of the specific equipment or system described therein
2. Table of contents listing sections, paragraphs, subparagraphs, and the page numbers where each one starts
3. General introduction and overall equipment and system descriptions, including purpose, function, and simplified theory of operation
4. Safety considerations including load limits, voltages, capacities, speeds, temperatures, and pressures
5. Start-up sequence instructions, operating instructions, and instructions for both normal and emergency shutdown sequences
6. Recommended procedures and frequencies for preventive maintenance including inspection, tests, adjustment, lubrication, and cleaning
7. Required preventative maintenance and frequency to ensure warranties
8. Troubleshooting, checkout, repair, and replacement procedures
9. List of test point locations for troubleshooting, and normal operating test values at each point provided
10. List of lubricants and other consumables for each item of equipment, and approximate quantities needed per year; where possible, types of consumables shall be consolidated, with equipment manufacturer's approval, to minimize the number of different consumables required
11. List of tools and equipment required for testing and maintenance
12. Complete equipment list, supplier's equipment specifications, and equipment and product data
13. Complete parts lists for each item of equipment reflecting the manufacturer's name, address, and telephone number; part number, nomenclature and exploded views of each assembly
14. Spare parts list and information described in paragraph entitled "Spare Parts Lists"
15. Mechanical, electrical, and instrumentation schematics and diagrams for each item of equipment and the integrated systems
16. Instrument/equipment calibration instructions, including calibration set points where applicable
17. "As-Built" drawings and shop drawings
18. Warranties including the name, address, and telephone number of the firm providing the warranty service.

O&M manuals shall be suitable for copying and microfilming.

PRODUCT DATA:

Where specifically required by other sections, product data shall be provided. Product data shall include descriptive material, such as catalog data, diagrams, color charts, and other data

published by the manufacturer, as well as evidence of compliance with safety and performance standards. To demonstrate conformance to the specified requirements; catalog numbers alone will not be acceptable. The data shall include the name and address of the nearest service and maintenance organization that regularly stocks repair parts.

Product data submittals shall reference the applicable subdivision and drawings, and be complete for each item or unit of work.

SAMPLES:

Where specifically required by other sections, samples shall be provided. Samples shall be identical with final condition of materials or products proposed for the work. Two full sets of optional samples shall be provided when required. Information shall be provided with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards. If requested by the Subcontractor, one sample set may be returned to be incorporated in the work. If incorporated into the work such sample shall be labeled in an approved manner and the installed location recorded on "Redline" drawings.

SHOP DRAWINGS:

Where specifically required by other sections, shop drawings shall be provided. Each shop drawing submittal shall be complete and shall be accompanied by technical and performance data as necessary to fully illustrate the information in the shop drawings, or cross referenced to such data contained in previous submittals. Unless otherwise specified, submittals shall consist of black-line printed copies. Hard copies and an electronic copy shall be submitted where required by other specification sections. Electronic copies of CAD generated drawings shall be provided in a form that will transfer to the Contractor's software using IGES or custom software provided by the Subcontractor. Sepia type prints are not acceptable. One set of copies will be returned to the Subcontractor marked to show the required corrections or approval.

The tag number indicated on the design drawings shall identify all equipment or other devices on the shop drawings. The Subcontractor shall identify all equipment and devices with tags or labels in accordance with the requirements specified in the respective subdivision.

The following additional submittals shall be required as indicated on the Vendor Data Schedule:

> "Redline" Drawings: Copies of the shop drawings shall be updated to include all changes or modifications made during construction and to reflect the actual conditions of construction. Each drawing shall be marked "As-Built," signed by the Subcontractor representative, and be suitable for XEROX copying or microfilming.

Title Block and Identification: On each shop drawing, a 1-1/2 x 2-1/2 in. space shall be provided for the Contractor's review status stamp. Each shop drawing shall include a title block showing:

1. Project name and location
2. Name and address of Subcontractor or manufacturer as applicable
3. Date, scale of drawings, unique drawing identification number, and referenced design drawing number
4. Subcontractor's review and approval stamp or signatures
5. Revision record including signatures and dates.

Preparation and Size: Details and information shall be clearly drawn, dimensioned (including tolerances), noted, cross referenced and shall be of such quality as to ensure legible B (11 x 17 in.) size photocopy reproductions from microfilm (by others). Drafting and drawing standards shall be consistent with the practices established by ANSI Y14.1 or other acceptable standards and as specified herein:

Where applicable, views shall be oriented so that plant north faces up or to the left.

Use of abbreviations shall be avoided where space permits spelling in full; if used, abbreviations shall be described in a legend on the drawing.

Types: Shop drawings shall be of the specific types specified in the respective subdivisions. If a specific type is not specified, drawing shall be the type most commonly required for the specific class of work subject to the Contractor's approval. The most commonly required types of shop drawings and drawing content (as applicable) are described hereinafter.

Connection Diagrams: Shall indicate the relationships and connections of devices and apparatus. They shall show the general physical layout of all controls, the interconnection of one system, or portion of system, with another, and all internal tubing, wiring, and other devices. For simple installations, connection diagrams and interconnection diagrams may be combined onto a common drawing.

Control Diagrams: Shall show the physical and functional relationship of equipment. Electrical diagrams shall show size, type, of the systems. Pneumatic diagrams shall be furnished where gas systems are used. For simple installations, control wiring diagrams may be combined onto a common drawing.

Composite Drawings: Composite drawings shall show the work of one trade with that of other trades in the same contract and the structural and architectural elements of the work. Composite drawings shall be in sufficient detail to show overall dimensions of related items, clearances, and relative locations of work in allotted spaces.

Detail Drawings: Shall consist of dimensioned fabrication and assembly drawings for all parts of the work in such detail to enable the Contractor to check conformity with the contractual requirements.

Elementary Diagrams: Shall indicate, in straight-line form, without regard for physical relationship, all supporting systems and elements of equipment and associated apparatus.

Layout Drawings: Shall be consolidated for all trades in the subcontract, and show to scale pertinent structural and fenestration features and other items, such as cabinets, required for installation and which could affect the available space. Mechanical and electrical equipment and accessories shall be shown to scale in plan, elevation and/or section, in their installed positions. Duct work, plumbing, and piping shall also be indicated. Submittals describing the various mechanical and electrical equipment items, which are to be installed in areas represented by layout drawings, shall be assembled and submitted concurrently with and accompanied by the room layout drawings.

Fabrication, Erection, and Installation Drawings: Shall indicate equipment arrangement and shall include dimensions, elevations, sections, and enlarged details showing proper methods of field fabrication, construction, and installation.

Interconnection Diagrams: Shall be to scale and indicate interface between associated units of equipment and between equipment and systems. Internal equipment connections shall be shown on the connection diagrams. For simple installations, connection and interconnection diagrams may be combined onto a common drawing.

Outline Drawings: Shall indicate overall physical features, dimensions, ratings, center of gravity, lifting points, service requirements, and weight of equipment.

Schematic Drawings: Shall show the functional flow of systems and their interfaces with facilities and other systems. Functional and physical interfaces shall be indicated. Schematics need not be to scale. Schematic may be structural, mechanical, electrical, instrumentation or any combination of these with respect to the equipment or systems to be installed.

Single-line Diagrams: Shall indicate, by means of single lines and simplified symbols, the paths and component parts of systems. Items shall be clearly labeled to indicate ratings and use in the system.

Wiring Diagrams: Shall identify all terminals, terminal blocks, and wires with wire numbers and colors. All wires within enclosures and all wiring connections to externally located equipment and devices shall be shown. For simple installations, wiring diagrams and control diagrams may be combined onto a common drawing.

Isometric Drawings: For piping systems, indicate three-dimensional piping layouts in the isometric format. Piping shall be represented as a single-line and in-line components shall be represented with standard drafting symbols.

SPARE PARTS LISTS:

Where specifically required by other sections, spare parts lists shall be provided. Spare parts lists shall include all spare parts and the current list price of each spare part. The spare parts lists shall also identify those spare parts, which each manufacturer recommends for maintenance at the site. Each manufacturer or vendor shall indicate the name, address, and telephone number of its spare parts source closest to the INEEL.

The Subcontractor shall cross-reference all spare parts lists to the equipment tag numbers designated in the specifications or on the drawings. If O&M manuals are specified for equipment, spare parts lists shall be submitted as part of the O&M manual.

CALCULATIONS:

Where specifically required by other sections, calculations shall be provided. Engineering calculations and analyses shall be fully checked by a qualified individual other than the originator, and shall be signed and dated as checked. All final submittals of calculations shall be bound and shall include the title and purpose of the calculation, a table of contents or index, complete list of references, design basis and complete list of assumption (if any), methodology, and sufficient information to allow independent verification of the calculation.

Calculations that are performed by computer or with computer assistance shall include a description of the hardware and software used, a description of the model employed if applicable, verification documentation for the computer program, and a copy of the computer input and output. All revisions to submitted calculations, as a result of comments by the Contractor or design changes by the Subcontractor, however minor, shall be resubmitted.

SPECIAL PACKAGING, HANDLING, OR STORAGE PROCEDURES:

Where specifically required by other sections, special packaging, handling, rigging, shipping, storage, or preservation procedures shall be provided. These procedures shall contain the following minimum requirements as applicable:

1. Measures taken to prevent damage during transit
2. Detailed description of container design
3. Overall dimensions and approximate weight of container and contents
4. Recommended method for off-loading
5. List of required special off-loading devices
6. Special instruction for proper packaging and preventative maintenance during storage at the site
7. Special instructions for marking
8. Safety code labels, if applicable.

INTEGRATED MANUFACTURING, INSPECTION, AND TEST PLAN:

Where specifically required by other sections, an integrated manufacturing, inspection, and test plan shall be provided. The integrated plan shall itemize the manufacturing, inspection, and/or test procedure steps associated with initial material preparation through end product delivery. The plan shall incorporate "source inspection hold points" as specified in the individual section.

PART 3--EXECUTION (NOT APPLICABLE)

END OF SECTION 01300

SECTION 02140--TEMPORARY DIVERSION AND CONTROL OF WATER DURING CONSTRUCTION

PART 1--GENERAL

SUMMARY:

Section Includes: Work includes, but is not limited to:

Furnishing of all materials, labor, tools, and equipment for dewatering work areas and controlling surface water prior to and throughout construction operations. Control measures implemented may include berms, swales, ditches, temporary piles, portable pumps, silt fences, sediment traps, or any other measure approved by the Contractor in accordance with this specification and as shown on the design drawings.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

1. Health and Safety Plan (HASP) for the Remedial Action Waste Group 3, Operable Unit 1-10
2. Comprehensive Remedial Design/Remedial Action Work Plan for the Test Area North Operable Unit 1-10, Selected Sites.

SUBMITTALS:

Procedures: Storm water control procedure and dust control procedures shall be submitted for approval prior to the start of the work detailing the Subcontractor's proposed storm water control measures. The procedures must meet the requirements specified in the project Environmental Checklist and shall be approved by the Contractor and implemented as approved before excavation may begin, and shall comply with the preliminary grading plan shown in the drawings.

Records: The Subcontractor will submit all records of inspection to the Contractor within four work days after completion of the inspection.

PART 2--PRODUCTS

EQUIPMENT:

All equipment and tools will conform to the safety requirements of the Project Health and Safety Plan (HASP).

All equipment and tools used by the Subcontractor to perform the work will be subject to

inspection by the Contractor before the work is started and will be maintained in satisfactory working condition at all times.

The Subcontractor's equipment and work will be adequate and capable of controlling water prior to and throughout construction as required by this specification and the design drawings.

MATERIALS:

All materials will be furnished by the Subcontractor and will be subject to approval by the Contractor.

Selection of materials used for controlling storm water are the responsibility of the Subcontractor, but will follow the intent of the Storm Water Pollution Prevention Plan and be approved by the Contractor.

PART 3--EXECUTION

GENERAL:

All standing water outside the construction boundary may be left to infiltrate the soil.

The Subcontractor will perform all construction work in areas free of standing water. Suitable water control measures will be constructed at all locations where construction work may be affected by ponded storm water at the time of work.

The Subcontractor will divert surface water around the periphery of all construction areas by applying the preliminary grading plan as outlined in the drawings.

The Subcontractor will be solely responsible for the protection of work against damage, delay, or environmental impact by water flow.

The Subcontractor will direct and control water in a manner that protects adjacent structures and facilities.

The Subcontractor will at all times minimize the creation and emission of dust. The Subcontractor will employ means such as water spray and visual observation to control and minimize dust. The source of water for dust suppression will be the TAN fire water system. The Subcontractor shall supply appropriate equipment for water delivery, storage, and application.

WORK IN DURING STORM ACTIVITY:

In the event of storm activity, the Subcontractor will provide protective measures to prevent damage to the work by run-on and maintain control of the run-off from the constructed areas.

During storm events, the Subcontractor will protect slopes by methods approved by the Contractor. Prior to re-starting work after a storm event, the Subcontractor will inspect and clean out all temporary control structures of debris and sediment buildup, and repair or replace any damaged areas either in the temporary control structures or in the permanent work areas as approved by the Contractor.

INSPECTIONS AND REPAIRS:

The Subcontractor will inspect temporary water control structures and materials on a daily basis and will record inspection findings in the daily work log. The inspection records will be submitted weekly to the Contractor.

The Subcontractor will remove debris and sediment build-up from the temporary control structures as required to maintain the intended flow path.

Should overflow or breach conditions be encountered or any other damage observed at the temporary structures, repair and/or replacement of the damaged area will be performed by the Subcontractor.

Acceptance criteria for repaired and/or replaced temporary water control structures will be in accordance with the requirements of this specification.

REMOVAL OF TEMPORARY CONTROL MEASURES:

Temporary storm water control measures will be removed once the work has been completed and as directed by the Contractor. The Subcontractor will properly dispose of the materials removed as directed by the Contractor. All areas where temporary control structures are removed will be regraded and revegetated in accordance with Sections 02200 and 02486 of these specifications.

ACCEPTANCE:

The Subcontractor will submit a description of any repair or replacement work required to the Contractor prior to implementation. Acceptance criteria for repaired or replaced water control measures will be in accordance with the original requirements of this specification.

END OF SECTION 02140

SECTION 02200--EARTHWORK

PART 1--GENERAL

SUMMARY:

Section Includes, but is not limited to:

1. Clearing and grubbing as required
2. Construction of soil staging area
3. Excavating all materials encountered, of every description, for completion of the Subcontract as shown on the drawings and as specified herein
4. Backfilling of all excavation
5. Compacting all fill, backfill and subgrade as specified herein
6. Finish grading and grading for surface drainage.

Related Section: Section 02140, Temporary Diversion and Control of Water During Construction.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (AASHTO)

AASHTO	Standard Specifications for Transportation Materials and Methods of Sampling and Testing
AASHTO M145	Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
AASHTO T11	Standard Method of Test for Materials Finer Than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T99	Standard Method of Test for the Moisture-Density Relations of Soils Using a 5.5 lb Rammer and a 12 in. Drop
AASHTO T238	Standard Method of Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

CODE OF FEDERAL REGULATIONS

29 CFR 1926	OSHA Safety and Health Regulations for Construction, Subpart P

IDAHO TRANSPORTATION DEPARTMENT (ITD)

SSHC Standard Specification for Highway Construction

SUBMITTALS:

No submittals required for this section.

PART 2--PRODUCTS

MATERIALS:

Satisfactory Soil Materials: Satisfactory soil materials are defined as those complying with AASHTO M145, soil classification Groups A-1, A-2-4, A-2-5.

Unsatisfactory Soil Materials: Unsatisfactory soil materials are those defined in AASHTO M145 soil classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7; also peat and other highly organic soils.

Backfill and Fill Material: "Satisfactory" soil materials free of clay, rock, gravel larger than 3 in. in any dimension, debris, waste, frozen materials, vegetable and other deleterious matter. Select pit run gravel is available at the TAN gravel pit. Gravel pit material and use of the gravel pits shall be at no cost to the Subcontractor. Upon completion of operations involving fill material removal, the Subcontractor shall grade and reshape the disturbed areas. Sloped surfaces shall meet the requirements of OSHA 29 CFR 1926.

Leveling Course Material: Naturally or artificially graded mixture of 3/4 in. maximum size crushed gravel, meeting the requirements of ITD SSHC subsection 703.04.

Sand Bedding: AASHTO M145, soil classification Group A-3.

HDPE Cover: Provide and install a high-density polyethylene smooth sheet, with the following minimum properties:

Yield Strength: 63 Lb/in ASTM D638
Break Strength: 114 Lb/in ASTM D638
Yield Elongation: 12%
Tear Resistance: 21 Lb ASTM D1004
Puncture Resistance: 54 Lb ASTM D4833

PART 3--EXECUTION

EXCAVATION:

Clearing and Grubbing: All areas as indicated by the drawings shall be stripped and cleared of all brush, weeds, rubbish and organic matter. All vegetable matter, roots, brush and debris

encountered during the stripping operations shall be removed from the cleared areas to a depth of at least 4-in. below the subgrade. Resulting depressions shall be completely backfilled and compacted in accordance with the applicable part of these specifications except in those cleared areas where further excavation is required. Stripped material shall be stockpiled or disposed of as specified hereinafter.

Earth Excavation: Earth excavation includes removal and disposal of pavements and other obstructions visible on ground surface, underground structures and utilities indicated to be demolished and removed, soil material of any classification, and other materials encountered that are not classified as rock excavation or unauthorized excavation.

Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond indicated elevations or dimensions without specific direction by the Contractor. Unauthorized excavation, as well as remedial work directed by the Contractor, shall be at the Subcontractor's expense.

Stockpiling and Disposal: All excavated material shall be removed and disposed of at the designated disposal facility. Excavated material that cannot be directly transported for disposal shall be stock piled in a designated area until final disposal.

Unstable Soils: If wet or otherwise unsatisfactory soil is encountered in an excavation, at or below the excavation line, it shall be brought to the attention of the Contractor and removed as directed in accordance with Article 38, "Differing Site Conditions," of the General Provisions.

Shoring and Bracing: The sides of all excavations shall be sloped or securely shored and braced in accordance with OSHA 29 CFR 1926, Subpart P.

BACKFILL OR FILL:

General: The excavations shall be cleared of all trash and debris prior to backfilling or filling. All backfill or fill material shall be free from trash, organic matter and frozen particles. Backfilling or filling shall be done only when approved by the Contractor. In excavations that are shored, shoring and formwork shall be removed or raised as backfill or fill is placed.

Placement: Concentrated dumping of backfill or fill material into excavations will not be permitted. No water shall be used for placing, settling or compacting backfill or fill except to obtain optimum moisture content. All material must be placed in uniform layers not to exceed 8 in. loose measurement and brought up simultaneously and evenly on both sides of foundation walls and around underground or covered structures and equipment such as culverts, manholes, and pipe. Backfill or fill around piping, and at least 4 in. over, shall be hand placed and compacted. Care shall be taken when backfilling, filling, or compacting around any buried items to prevent injury to the item being covered. Loose backfill or fill may be placed as specified hereinafter.

Compaction: Unless otherwise indicated on the drawings or specifications, compact all backfill using mechanical devices such as rollers, vibratory compactors, or mechanical tampers. Unless otherwise indicated, all "compacted" backfill or fill shall be compacted to at least 95% of maximum density at optimum moisture content as determined by AASHTO T99. Each loose measurement lift shall be 8 inches maximum and shall be compacted before the next lift is placed thereon. Compacted backfill or fill density and moisture content may be measured by the Contractor at any location and depth. Sections of backfill or fill failing to meet the minimum compaction requirements shall be corrected prior to placement of subsequent lifts. No heavy equipment shall be allowed over piping until a minimum of 24 in. of backfill has been compacted over the piping.

Grading: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations. Slope grades to direct water away from buildings and to prevent ponding. Provide a smooth transition between adjacent existing grades and new grades.

HDPE Stock Cover: Install liner and cover in accordance with manufacturer's instructions. Seams shall be prefabricated by the manufacturer to the extent possible. Field seams shall comply with the manufacturer's instructions.

EQUIPMENT:

Watering Equipment: Provide water tank trucks capable of applying a uniform unbroken spread of water over the surface. A suitable device for positive shut-off and regulation of flow shall be located to permit operation by driver in cab.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 02200

SECTION 05100--STRUCTURAL STEEL AND MISCELLANEOUS METALS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall supply all labor, equipment, and materials required to construct items listed hereafter and as shown on the drawings.

Section Includes: Work includes, but is not limited to:

Structural steel framing for Tank Support Skid

Carbon steel plate for Secondary Containment Pan

Steel spreader beam

Steel shielding plates and frames

Miscellaneous steel.

REFERENCES:

The following documents including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC	Code of Standard Practice for Steel Buildings and Bridges
AISC (ASD)	Specification for Structural Steel Buildings - Allowable Stress Design (ASD) and Plastic Design

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z49.1	Safety in Welding

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	Symbols for Welding, Brazing, and Nondestructive Examination
AWS B2.1	Specification for Welding Procedure and Performance Qualification
AWS D1.1	Structural Welding Code - Steel
AWS D14.1	Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment

The following specifications are referenced in regard to materials:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36	Structural Steel
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing

AMERICAN SOCIETY OF MECHANICAL ENGINEERING (ASME)

ASME B30.20	Below the Hook Lifting Devices

SUBMITTALS:

Submittals include, but are not limited to the following:

Welders: Submit certified copies of welders qualification test records.

Spreader Beam Certification: Pre-manufactured spreader beam supplier shall submit a proof test certification in compliance with ASME B30.20, "Below the Hook Lifting Devices." Manufacturer shall submit certification of proof testing and construction to ASME B30.20.

QUALITY CONTROL:

Qualification for Welding Work:

Off-Site: Qualify welding processes and operators for shop welding in accordance with AWS D1.1, and D14.1 as applicable to work performed.

On-Site: Qualify welding operators for on-site (field) welding in accordance with the INEEL Welding Manual. On-site welding will be performed to WPS C3.5 or C6.10, as applicable. All welders shall be qualified at the INEEL Welder Test Facility.

DELIVERY, STORAGE AND HANDLING:

Store material to permit easy access for inspection and identification. Protect members and materials from corrosion and deterioration.

Do not store materials in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials that do not meet these specifications.

PART 2--PRODUCTS

MATERIALS:

Structural Steel W Shapes: ASTM A 992.

Structural Steel C, S, M, and HP Shapes: ASTM A 36.

Miscellaneous Steel Plates, Angles and Bars: ASTM A 36.

Cold-Formed Steel Tubing: ASTM A 500, Grade B.

Steel Pipe: ASTM A 53, Type E or S, Grade B or ASTM A 120, Grade B.

Electrodes: Comply with AWS D1.1 or AWS D14.1 as applicable for shop welding. Comply with INEEL Weld Procedures indicated for field welding.

Spreader Beam: Design and fabricate to ASME B30.20. Rated capacity shall be as shown on drawings.

FABRICATION:

Shop Fabrication and Assembly: Fabricate items of structural steel in accordance with AISC ASD Specification.

Fabrication and assembly shall be done in the shop to the maximum extent possible.

Connections: Weld connections, as indicated.

Weld Construction: Comply with AWS D1.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

Spreader Beam Welding: Comply with AWS D14.1 for procedures, appearance and quality of welds, and methods used in correcting welding work.

PART 3--EXECUTION

FIELD QUALITY CONTROL:

Contractor Supplied Testing: The Contractor's Representative will inspect welded connections and perform tests and prepare test reports unless noted otherwise. The Contractor's Representative will perform visual inspection of all field welds in accordance with the requirements of Section 6 of AWS D1.1 or AWS D14.1 as applicable. He may also perform a visual receipt inspection of shop welds.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawing and specifications.

Subcontractor Supplied Testing:

Shop Welding: Certify welders, inspect and test during fabrication of structural steel per AWS D1.1, AWS B2.1 or AWS D14.1 and AISC ASD Specification. Record types and locations of defects and work required and performed to correct deficiencies. As a minimum, visually inspect all welds per Section 6 of AWS D1.1 or AWS D14.1, as applicable.

Spreader Beam Rated Load Test: Subcontractor fabricated spreader beams shall be tested and inspected before use. Load testing shall be performed in accordance with ASME B30.20. Upon completion of test, inspect (visual) beam for deformation, cracks or other defects.

END OF SECTION 05100

SECTION 13207--TANKS

PART 1--GENERAL

SUMMARY:

The vendor shall provide three (3) vertical tanks in accordance with the requirements of this section and drawing P-10.

REFERENCES:

As a minimum, the design, fabrication, inspection, and testing of the tanks shall comply with the applicable requirements of the following standard(s):

AMERICAN PETROLEUM INSTITUTE (API)

API 650	Welded Steel Storage Tanks for Oil Storage
API 650, Appendix J	Shop Assembled Storage Tanks
API 650, Appendix S	Austenitic Stainless Steel Storage Tanks

SUBMITTALS:

The vendor shall submit, as a minimum, three (3) copies the following information for review and approval.

1. Shop drawing(s) stamped by a registered P.E. showing the details of the tank with all dimensions. The drawing shall include the empty weight of the tank and the design loads for support legs assuming the tank is full to with water
2. Tank structural calculations stamped by a registered professional engineer
3. Instructions for tank handling and off-load at the customer site
4. Manufacturer qualifications showing experience in fabricating stainless steel tanks.

QUALITY ASSURANCE:

Registered Professional Engineer Calculations: The vendor shall submit shop drawings and calculations prepared and stamped by a registered professional engineer showing the adequacy of the design of the tank, its supporting structure and the lifting attachments.

Manufacturers Qualifications: The manufacturer shall be regularly engaged in the manufacture of stainless steel tanks of types and sizes required and have products in satisfactory use in similar service for not less than 5 years.

PART 2--PRODUCTS

TECHNICAL REQUIREMENTS:

Each tank shall have a total capacity of approximately 8,000 gal. and shall be configured as shown on the drawings. Each tank shall be a vertical, 10 ft nominal diameter tank as shown on the drawings. The tanks shall be designed for maximum pressures of -5 inches W.G. to +5 psig. A pressure/vacuum relief device shall be provided on each tank to ensure that the tank pressure is maintained within the maximum pressure with a maximum relief flow of 50 cfm.

Tank Baffles: Each tank shall be provided with four (4) vertical internal baffle plates (1/4" thick) equally spaced around the diameter of the tank as shown on the drawing. The baffles shall have a 1.7 in clearance (offset dimension) between the baffle and the tank wall.

Sparge Pipe: Each tank shall be provided with a 1" sparging pipe as shown on the drawings.

Tank Loads: The tank structure shall be designed for the expected dead and live loads (including seismic) and the additional loads as specified on the drawing. The tank top shall be reinforced to support loads acting on the tank as identified on the drawing. The tank shall be designed to be lifted and handled empty (no internal liquid during movement). Structural calculations shall be provided to show that all loads have been considered.

PART 3--EXECUTION

GENERAL:

The tanks shall be all welded construction with a nominal 3/8" wall thickness. Flange bolting patterns shall split the centerlines. The vendor shall provide external reinforcement where necessary to support equipment loads identified above. Welding shall be performed in accordance with API 650.

CLEANING:

The interior of the tanks shall be clean at the time of shipment. All scale, dirt, and other materials shall be removed from the interior tanks surfaces. Grease, oils, and other organic compounds shall be cleaned and removed from the interior tanks surfaces.

INSPECTION:

Inspections shall be performed as identified in API 650. The Contractor's Representative reserves the right to witness testing of the tanks and inspect the finished tanks prior to shipment by the manufacturer.

PACKAGING AND SHIPPING:

The tanks shall be provided with lifting attachments for lifting of the tanks from a horizontal shipping position to the vertical position, and for lifting and moving the tanks while in the vertical position. All connecting flange surfaces shall be protected from shipping damage. Flanged piping connections shall not be used to lift or handle the tanks. The vendor shall cover all openings to maintain the cleanliness of the interior of the tank. The tank shall be designed to be lifted and handled empty (no internal liquid during movement).

ACCEPTANCE:

The tanks shall be inspected upon arrival at the INEEL for damage to the tank exterior and flange surfaces.

END OF SECTION 13207

SECTION 15024--PRESSURE PIPING/VESSEL WELDING

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish all labor, materials, equipment and services necessary to perform all pressure piping/vessel welding required in accordance with the Subcontract drawings and the following requirements:

Design, testing, inspection, filler materials and workmanship requirements shall conform to the appropriate code

Welds will not be accepted unless the welding has been specified or indicated in the design documents or otherwise approved. Welding shall be as specified in this Section except where additional requirements are indicated or are specified in other sections.

Work includes, but is not limited to:

Welding of metallic piping, vessels, and equipment

Integral attachments to piping, vessels, and equipment including other pressure boundary welds.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z49.1	Safety in Welding and Cutting

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	Personnel Qualifications and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	Symbols for Welding and Nondestructive Testing
AWS A3.0	Welding Terms and Definitions
AWS B2.1	Specification for Welding Procedure and Performance Qualification

AWS QC1 AWS Standard for Qualification and Certification of Welding Inspectors

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3 Chemical Plant and Petroleum Refinery Piping

BOILER AND PRESSURE VESSEL CODE (BPV)

Section II Material Specifications
Section V Nondestructive Examination
Section VIII Pressure Vessels
Section IX Welding and Brazing Qualifications

IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY (INEEL)

INEEL Welding Manual

DEFINITIONS AND SYMBOLS:

Definitions for welding terms shall be in accordance with AWS A3.0 and ASME Section IX as applicable. Weld symbols shall be in accordance with AWS A2.4, unless otherwise indicated.

SUBMITTALS:

Vendor data requirements are summarized on the Vendor Data Schedule.

Submittals include but are not limited to the following:

Cleaning procedures for stainless steel

Subcontractor's procedure for identification and control procedures for tools and equipment

Welding Procedure Specifications (WPS) and Procedure Qualification records (PQR) performed in accordance with ASME BPV Code, Section IX for off-site welding including a list of procedures selected for use from the INEEL Welding Manual. These procedures shall be referenced on the shop drawings, erection drawings, and contract drawings as applicable

Welding personnel performance qualification records

Subcontractor's nondestructive examination procedures

Subcontractor's nondestructive examination personnel qualification records

Handling, storage, and control procedures for filler materials and backing material

Filler metal manufacturer or independent testing lab certified mill test reports (CMTR) of actual chemical properties and heat number identification for all filler metals. The heat number shall be marked on the CMTR. The CMTR shall certify that the material has been inspected and tested in accordance with the requirements of the specification and that the results of the chemical analysis meet the requirements of the specification for the AWS material classification

Weld histories, including requirements listed in Special Conditions, such as reports of each inspection, examination and test

Detailed weld repair procedures

Weld repair reports including weld identification, welder identification number, test procedure, reason for rejection, number of repairs required, and documentation that weld is repaired and accepted

Weld map which shall include the following information: weld procedure specification, unique identification number including welder's identification and completion date

Shop drawings shall show all welds. All necessary information such as location, size, weld preparation, etc. shall be shown. The drawings shall differentiate between shop and field welds. Weld procedures, NDE requirements, and filler material to be used shall be indicated

Purge dam control procedure which shall include the prohibition of dissolvable purge dam material for pneumatically flushed piping systems and include methods to assure removal of all purge dams.

QUALITY CONTROL:

Codes and Standards: Comply with requirements of the current revision of the following codes and standards, as specified in this specification:

ASME B31.3 Process Piping, Category M Fluid Service

General: Components with welds will not be accepted unless the welding has been specified or indicated in the design documents or otherwise approved. Welding shall be as specified in this Section except where additional requirements are indicated or are specified in other sections.

Weld Procedure Qualification: All welding shall be performed in accordance with the requirements of an approved welding program and qualified Welding Procedure Specifications (WPS).

Off-Site Procedures: For any welding which is performed, as a part of this subcontract, off of the INEEL Site, the Subcontractor shall establish and qualify all Welding Procedure Specifications in accordance with the requirements of an approved Welding Program and ASME Boiler & Pressure Vessel Code, Sec IX.

Alternately the Subcontractor may use welding procedures from the INEEL Welding Manual as specified in PART 3 EXECUTION - Welding Processes paragraph for off-site welding if a letter is submitted as vendor data stating that these procedures are being adopted for use in performance of this subcontract.

On-Site Procedures: Any welding which is performed on the INEEL site shall be performed in accordance with the qualified Welding Procedure Specifications as provided by the Welding Manual and Part 3--EXECUTION of this section.

Welder Qualification:

Off-Site: All welding which is performed off of the INEEL site shall be performed by welders or operators qualified in accordance with an approved Welding Program and ASME BPV Code, Section IX. Welders or welding operators qualified to INEEL Welding Manual procedures can be used for off-site welding if the applicable INEEL weld procedures are identified and submitted as Vendor Data. When using INEEL Welding Manual procedures for off-site welding, welders shall be qualified at the INEEL Welder Test Facility.

On-Site: All on-site welding performed under this specification shall be performed by welders or welding operators qualified at the INEEL Welder Test Facility using the applicable procedures specified from the INEEL Welding Manual.

Certification: Upon successful completion of the qualification test, the welder shall be provided with a certificate card by the Subcontractor (off-site) or in compliance with the INEEL Welding Manual (on-site). The certificate shall state the welding process, codes, and procedures under which the welder is qualified, and individual who issued the certificate. The welder shall carry the certificate card when performing welding under this contract. The Subcontractor shall have on file documentation, affidavits, and records of testing and test results which qualified the welder for certification. These records shall be certified by the Subcontractor and shall be submitted to the Contractor as vendor data.

Welder's Identification: The Subcontractor shall assign each welder with an identifying number, letter, or symbol which shall be used by the welder to identify all welds made by him.

Renewal of Qualification: Renewal of qualifications for a welder or welding operator working on-site shall be in accordance with the INEEL Welding Manual. Renewal of qualifications of a welder or welding operator working off-site shall be as required in ASME BPV Code, Section IX.

Non-destructive Examination Procedures: The Subcontractor shall establish detailed inspection procedures, including the applicable acceptance criteria for each non-destructive examination method specified in PART 3--EXECUTION - QUALITY CONTROL AND TESTING and additionally as required to ensure conformance of the work to the contractual requirements.

Subcontractor's Non-destructive Examination Personnel Qualifications: The Subcontractor's non-destructive examination (including visual examination) personnel shall be qualified for the applicable nondestructive testing method in accordance with the requirements of ASNT SNT-TC-1A for Levels I, II, or III as applicable. Qualification as an AWS Certified Weld Inspector is an acceptable alternative for visual examination. The Subcontractor shall have on file documentation, affidavits, and records of testing and test results which qualified the non-destructive examination personnel. These records of education, training and experience to validate qualification shall be submitted as vendor data.

DELIVERY, STORAGE, AND HANDLING:

Filler metal and backing materials shall be stored, handled and controlled in accordance with an approved Filler Metal and Backing Material Handling, Storage and Control Procedure. As a minimum the procedure shall include the Manufacturer's Recommendations and the requirements of Volume 2 of the INEEL Welding Manual.

SAFETY:

As a minimum, safety precautions during welding shall conform to ANSI Z49.1 as well as any additional requirements specified in the subcontract documents.

PART 2--PRODUCTS

GENERAL:

Welding equipment, electrodes, filler material, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator utilizing qualified welding procedures.

MATERIALS:

Filler Material: All filler material used in fabrication shall comply with the applicable requirements of ASME BPV Code, Section II, Part C or the equivalent AWS filler material specification and shall have an actual certified material test report (CMTR) issued by the original manufacturer, or independent testing laboratory performing material testing for each

lot/heat number submitted to the Contractor for approval before use. Filler metal shall be marked with the heat number and the AWS material classification. Straight lengths of bare filler metal shall be marked on each end and spools of bare filler metal shall be marked on the side of the spool. Unless otherwise specified the filler metal shall be in accordance with the specified WPS.

Filler material shall be ER308L.

Gases: Shielding and purge gas(es) shall be in accordance with the applicable weld procedure.

Purge Dam Materials: The use of internal purge dams such as inflatable balloons or water soluble paper shall be per the INEEL Welding Manual and Part 3--EXECUTION - Purging Materials. All water-soluble paper purge dams shall be approved prior to use.

Film: Radiographic film for radiographic examinations required by these specifications shall be fine-grained high contrast industrial radiography film. The Subcontractor shall supply radiographic film and services for all radiograph examinations at his own expense.

PART 3--EXECUTION

WELDING OPERATIONS:

Both off-site and on-site welding shall be accomplished in accordance with qualified and approved welding procedures using qualified welders and/or welding operators. The use of such procedures will not relieve the Subcontractor of his responsibility for producing weldments conforming to the specified workmanship requirements. Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions.

Welding Processes:

Off-Site: Acceptable welding processes are:

Shielded Metal Arc Welding (SMAW)
Gas Tungsten Arc Welding (GTAW)
Flux Core Arc Welding (FCAW)
Gas Metal Arc Welding – Spray Transfer (GMAW)
Gas Metal Arc Welding – Pulsed (GMAW-P)
Submerged Arc Welding (SAW)

Gas Metal Arc Welding Short Arc (GMAW-S) process shall not be used.

Other welding processes may be used subject to specific approval. The Subcontractor shall submit pertinent data and proposed application of said other welding processes for evaluation by the Contractor prior to performing weld procedure qualification.

On-site and Off-site using INEEL Welding Manual, INEEL Welding Procedures as applicable.

Welding Procedures: All welding shall be in accordance with ASME B31.3 for Category M Fluid Service and the specified Welding Procedure Specifications from the INEEL Welding Manual.

Tools and Equipment: Tools and equipment used in the fabrication of stainless steel and nickel based alloys shall be free from corrosion and shall be maintained free of grease, carbon steel particles, or any other foreign matter detrimental to fabrication. Mechanical cleaning tools used for stainless steel shall not cause carbon steel to be embedded into the surface. Wire brush material shall be of a material compatible with the parent material. Grinding wheels shall be resin bonded. Metal removal tools, wire brushes, and grinding wheels shall not have been previously used for other than the parent material. The Subcontractor shall establish and maintain identification and control procedures for equipment and tools including wire brushes and grinding wheels.

Joint Preparation and Fit-up: Joint preparation including end preparation and alignment shall conform to the requirements of the applicable ASME code and the INEEL Weld Manual and to the following minimum requirements. Surfaces within 2 in. of any weld location shall be free of any oil, grease, paint, or other material that would prevent proper welding or produce objectionable fumes while welding. There shall be no free iron on the weld bead or heat-affected area of any stainless steel weld, nor on any surface where mechanical cleaning abrasion or other working of the metal surface has occurred. If the joints of carbon steel are prepared by arc or thermal cutting, the surface shall be ground to bright metal by mechanical means before welding. Plasma arc or laser beam cutting of joint preparations is permitted provided the cut surface is machined or ground a minimum of 1/16 in. to bright metal.

Piping prepared for use with socket weld fittings shall have ends ground smooth, square and flat, with no perceptible burrs or irregularities. When performing automatic pipe welding the pipe end preparation shall be made with tooling making the proper 90° end cut and the proper counterbore.

Pipe shall be cut accurately to suit field conditions. It is the responsibility of the Subcontractor to field verify dimensions indicated on drawings prior to fabrication. A template shall be used in laying out headers, laterals and other irregular details to ensure accurate cutting and a proper fit-up.

Cleaning Stainless Steel: The weld joint and surrounding metal for at least 2 in. back from the joint preparation shall be cleaned before welding. Cleaning shall be accomplished by brushing with a clean stainless steel brush and by scrubbing with a clean lint free cloth moistened with an approved low (less than 35 ppm) chloride or chloride-free solvent. When the weld has cooled, remove all visible weld spatter, arc-strikes, flux, and scale, however, the base material thickness shall not be compromised. Stainless steels shall not be descaled with nitric-hydrofluoric acid solutions. Final cleaning shall be performed after inspection and when nondestructive testing is complete.

Preheat and Interpass Temperature Requirement: Preheat and interpass temperature shall be in accordance with the welding procedure specification.

Welding Requirements:

General: Welds shall be designed to provide complete fusion with the base metal. Pressure retaining groove welds shall be complete joint penetration welds unless otherwise specified. Weld beads shall be contoured to provide complete fusion at the sides of the bevel and to prevent slag entrapment. Flux, weld spatter and slag shall be removed from each weld bead prior to depositing the succeeding pass. Arc strikes outside the area of permanent welds shall be avoided on base metal. Welds shall be finished as required for the applicable nondestructive examination method. Accessible welds on the inside surface of vessels prior to final closure shall be ground smooth and free of pits, crevices and sharp projections. Peening shall not be allowed.

Consumable Inserts: The use of consumable inserts shall only be permitted with prior approval of the Contractor.

Structural Attachments: Permanent structural attachments shall not be welded to pressure retaining parts unless such attachment is specified, indicated or approved by the Design Engineer. Such welds shall be inspected by the liquid penetrant method. Welding shall not be performed after final stress relief and/or hydrostatic testing.

Tack Welds and Temporary Welds: Qualified procedures and welders shall be used to make tack welds and to weld temporary attachments. Tack welds shall be inspected visually for defects and, if found to be defective, shall be removed. Areas from which temporary attachments have been removed shall be dressed smooth and inspected visually for conformance with the minimum thickness requirements of the parent metal, and shall be examined by the liquid penetrant method or magnetic particle method as specified. Welds found to be defective shall be repaired by a qualified welder and re-examined.

Post Weld Heat Treatment: Post weld heat treatment shall be as indicated and in conformance with the specified ASME code requirements and WPS.

Welding Sequence: Welds that are located under nozzle necks, external reinforcement or other obstructions shall be inspected and nondestructively examined prior to attachment of the obstruction. Welded joints connecting new piping or equipment to existing piping or equipment shall be made only after new piping or equipment has been successfully tested and cleaned.

Identification of Welds: The welder shall permanently affix his assigned identification mark and applicable weld identification number adjacent to the weld using a vibro-etch tool. The welder shall also record this information on the weld map.

PURGE PROCEDURE:

The shielding and backing gas composition and flow rates shall be as specified in the WPS and this specification. The purge gas shall have a dewpoint of -50° F or lower.

Purging shall be accomplished by using water-soluble purge dams or retrievable dams (preferred) or, where feasible, it is permissible to purge all or part of the system rather than use purge dams for each weld joint. Open butt weld joints may be sealed during pre-purge with an approved tape over the outside of the weld joint. Such tape shall be removed slightly ahead of welding the root pass.

Purging is to be maintained for the root pass and successive layers of welding to 3/16" minimum.

Water soluble paper purge dams shall only be used when other types of purge dams cannot be used and purging the entire line is impractical. Where the inside of a welded pipe joint is inaccessible after welding, i.e. closure ends, or the piping configuration does not permit removal of pressure sensitive tape, adhesive or other purge dam materials, water soluble paper dams and water soluble tape may be used or the entire line may be purged.

Purging devices such as balloons and dams are to be located outside the area being preheated, or subject to temperatures over 200° F, to prevent damage to the purge device or contamination of the components being welded.

Prior to welding, the open pipe ends which are butted together shall be covered with tape or a metal ring and the volume purged for approximately 6 volume changes or until the oxygen level decreases to 2% or less in the exit gas as measured by an oxygen analyzer. Flow rates higher than those specified on the WPS may be used to pre-purge the system to decrease purging times provided they are decreased to an acceptable range during welding.

The purge flow rates required to maintain a slight positive backpressure through the open butt and prevent entrance of air will depend on the size of the system being purged and the amount of leakage through the purge dam system. When required by installation conditions, the Contractor may direct that lower purge rates may be used. Also, higher flow rates may be utilized if the purged volume has a high leak rate. Any change to the purge rate specified in the WPS shall be approved by the Contractor.

Just prior to completing the root pass, the purge flow rate should be reduced to the lower range of the allowed purge flow rate to avoid creating internal root concavity due to excessive backpressure.

Purging Materials: Sealing tapes, adhesives, soluble paper or tapes in contact with austenitic stainless steel or nickel alloy surfaces shall not contain contaminants in excess of the following and shall satisfy the criteria listed below:

Total halogen (inorganic and organic) content 200 ppm

Sulfur content 200 ppm. Low melting-point metals shall not be added intentionally

Upon removal of external tape, all non-water soluble adhesives shall be removed by a non-halogenated solvent (acetone, alcohol or equal) wiping

Starch, silicone and epoxy type material may be used for tape adhesive

Pressure-sensitive adhesive tapes are available in many forms; glass cloth, polyethylene-coated cloth, polyester, polyester laminated to glass filament and polyethylene plastic. Colored tapes which contrast with the metals welded should be used to assure their removal after use. Paper-backed masking tape shall not be used

Tape and paper shall be purchased with either a Certificate of Compliance or a Certified Materials Test Report showing compliance with the halogen, sulfur and low melting-point metal contaminant limits specified above. A suggested supplier of tape and paper is Gilbreath International Corp. of Cornwall Heights, Penn. (215) 638-7100. Each batch or lot of water soluble paper or tape shall have its solubility tested by the manufacturer and be certified by the manufacturer as soluble in 60° F water.

Requirements for Use of Water Soluble Paper Purge Materials: A circular disc is cut slightly larger than the inside diameter of the pipe and shaped to the inside pipe circumference. A conically shaped dam is recommended.

For small bore pipe, insert the dams as far as practical using a convenient tool such as brush handle or file. The approximate three inch minimum set back from the weld end may be estimated.

Wadding of the paper into the pipe shall not be allowed.

The paper and tape shall be non-toxic, non-corrosive and shall meet the requirements above for purging materials.

The solubility of each roll of paper or tape shall be checked in 60° ± 10° F water prior to use. The Contractor's Representative shall be notified 8 hours in advance for the solubility test of rolls to be used.

Weld Repairs:

1. Defects shall be completely removed by grinding or other approved means to clean, sound metal. Defect areas shall be PT inspected by the Contractor's Representative to assure defect removal
2. Repairs to correct weld defects shall be made using the same procedure used for the original weld or other previously authorized weld repair procedures

3. Repaired areas shall be re-examined using the same inspection procedures by which the defect was originally detected and the inspection which was originally specified for the weld
4. No more than two repair attempts will be allowed on any one weld

    a. Cutting out and rebeveling then rewelding is considered a weld repair
    b. No further attempts to repair shall be carried out without the written authorization of the Contractor
    c. Weld repairs subsequent to the first two repair attempts shall be made only after receiving written approval of Subcontractor's repair procedures.

5. Arc Strikes: Cracks and blemishes caused by arc strikes shall be ground to a smooth contour but no more than 1/32 in. of the base metal shall be removed. Arc strikes extending more than 1/32 in. into the base metal shall be considered as a weld defect and repaired as specified. Ground arc strikes in carbon steel shall be subjected to magnetic particle examination and in stainless steel shall be subjected to liquid penetrant examination.

FIELD QUALITY CONTROL:

Inspections, examinations, and tests, for welds and weldments shall be performed by qualified inspection, examination, and testing personnel in accordance with the approved procedures. All welds are subject to inspection by the Contractor's Representative who reserves the right to accept, reject or demand removal of welds which are in violation of this specification or the applicable welding procedure specification. The Subcontractor shall provide access for this activity.

The Subcontractor shall coordinate the performance of non-destructive examinations with the fabrication and installation of the piping systems, so as to minimize interferences in the performance of both scopes of work and other unrelated work.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

Weld Testing and Inspections:

Visual Weld Inspection: All welds shall receive a visual (VT) examination in accordance with ASME Section V Article 9. VT inspection shall be performed, evaluated and documented by the Subcontractor for on-site welds and off-site welds. The evaluation of indications and the acceptance criteria shall be in accordance with ASME B31.3 for Category M Fluid Service.

Radiographic Examination: Radiographic (RT) examination and acceptance criteria shall be per ASME B31.3 for Category M Fluid Service. Radiographic examination shall include at least 1-1/2 in. of longitudinal welds that intersect circumferential butt

or miter groove welds being examined. Subcontractor shall perform and interpret results of both on-site and off-site radiography. Final interpretation and acceptance of the radiographs shall be by the Contractor's Representative. All radiographs and technique sheets shall be submitted to the Contractor for final interpretation and approval.

All butt welds for each welder shall be inspected as follows:

A minimum of 20 percent of the field butt welds and 20 percent of the shop butt welds shall receive radiography (by the Subcontractor) after the final weld pass is complete.

Radiographic weld selection shall be by the Contractor's Representative. The selection shall comply with ANSI B31.3, Chapter VI requirements including progressive examination.

The acceptance criteria shall be in accordance with ANSI/ASME B31.3, Category M Fluid Service, and this specification. Incomplete penetration is not allowed.

END OF SECTION 15024

SECTION 15203--PROCESS PIPING

PART 1--GENERAL

SUMMARY:

Section Includes, but is not limited to:

Furnish and install all valves, pipe, tubing, hose, flanges, fittings, couplings, supports, and appurtenances as required to complete the work as shown on the Subcontract drawings for the following subsystems of the Radioactive Waste System:

Sludge System – Includes moveable sludge suction lines, sump suction lines, pump suction lines, sludge pump, and sludge delivery lines

Consolidation Tank System – Includes consolidation tanks, consolidation tank pumps, consolidation tank recirculation lines, and the supernate/process feed line

Supernate Spray System – Includes supernate return line, spray lines, and spray wands

Tank Ventilation Systems – Includes ductwork from the V-tanks to the Off-Gas Skid area, and from the consolidation tanks to the Off-Gas Skid area, and the Consolidation Tanks HEPA Filters

Video System – Includes video cameras, video monitors, video recorders, and associated cables.

Fabricate, install, inspect, and test steel piping in accordance with the Subcontract specifications and drawings and ASME B31.3 Category M requirements. Comply with ASME B31.3 Chapters I through VII and the additional requirements of Chapter VIII, Piping for Category M Fluid Service.

Note: HDPE piping shall be pressure tested in accordance with the requirements of ASME B31.3 Category M fluid service piping.

Related Sections: All metallic piping welding and weld inspection shall be as specified in Section 15024.

REFERENCES:

The following document including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B31.3 Process Piping

MATERIAL DELIVERY, STORAGE, AND HANDLING:

The Subcontractor shall ensure that all materials are delivered in a new, undamaged, and protected condition. The finished materials shall be packaged for shipment, pipe ends and tube ends shall be capped with plastic caps to protect the material from dirt and contamination during shipment and subsequent storage

All materials shall be inspected by the Subcontractor prior to acceptance. If damage is found or any material identification and/or documentation is missing, the Subcontractor shall report the deficiency to the delivering carrier, the manufacturer, and/or the Contractor's Representative as appropriate.

Materials shall be resealed and repacked after inspection. The Subcontractor shall ensure that materials are stored in a manner to provide protection against damage, atmospheric corrosion and contamination.

SUBMITTALS:

Submittals include, but are not limited to the following:

HDPE Piping – Submit Certificate of Conformance for HDPE piping

Stainless Steel Piping – Submit material certification as described below under "Quality Control" section. Submit shop drawings including principal dimensions and details of construction, and sizes and location of piping and components

Consolidation Pumps – Submit pump package including pump curves and operation & maintenance manual

Test Procedures - Submit Test Procedures for all leak testing

Test Reports - Submit Test Reports for all leak testing.

QUALITY CONTROL:

Design, fabrication, installation, inspection, and testing shall be in accordance with the Subcontract specifications and drawings and ASME B31.3 Category M requirements.

Comply with ASME B31.3 Chapters I through VII and the additional requirements of Chapter VIII, Piping for Category M Fluid Service.

Qualifications: Piping and components shall be furnished and installed by a firm regularly engaged in this type of work, and shall maintain shop and facilities for fabrication and maintenance of subject equipment.

Items of Any One Classification: Items that are used in quantity, such as valves, specialties, accessories, fittings, etc., shall in each case be the product of one manufacturer, and shall be used only for the services recommended by the manufacturer.

Materials, Products and Equipment: Materials, products and equipment shall be furnished and installed in strict accordance with the Subcontract drawings and these specifications.

Material Certification: All stainless steel piping and fittings used in fabrication shall have actual certified material test reports (CMTRs) issued by the original manufacturer, or independent testing laboratory which certifies that the material is in accordance with the standard specified for each material. CMTRs shall include chemical analysis, heat numbers, and physical test results. CMTRs shall be submitted to the Contractor for approval prior to fabrication.

PART 2--PRODUCTS

MATERIALS:

General: All materials, products and equipment shall be as manufactured by the manufacturer specified in this section, or an approved equal. All materials furnished shall be permanently marked or tagged to show ASTM Designation and type of material. Materials shall not be steel stamped for identification.

Where instruments, valves, equipment or controls are specified, the descriptive narrative shall govern over the catalog part number or model number.

Unless otherwise specified, all pipes shall be sized according to the drawings. All valves, unless otherwise specified, shall be sized for the line into which they will be installed.

Sludge System:

HDPE Pipe and Fittings: HDPE piping shall be high density polyethylene pipe as manufactured by Chevron Phillips Chemical Company, DriscoPlex 8700 Series, PE 3408 HDPE Pipe, SDR 9.0. Fittings shall be manufactured to match the piping system. All HDPE piping within the encasement pipe shall be one continuous length, with no joints. Flange bolts shall be Chrome-Moly stud bolt, threaded full length, per ASTM A193, Grade B7 with semi-finished heavy Hex Nut per ASTM A194, Grade 2H. HDPE flanges shall include backing rings as recommended by the HDPE manufacturer.

HDPE Encasement Pipe: HDPE encasement piping shall be high density polyethylene pipe as manufactured by Chevron Phillips Chemical Company, DriscoPlex 8700 Series, PE 3408 HDPE Pipe, SDR 32.5. Fittings shall be manufactured to match the piping system.

Ball Valves: Ball valves shall be 150# Class, body shall be 316 stainless steel ASTM A351 GR. CF8M, flanged ends, full port, 316 SST Ball & Stem, Polyfill ball seat, Graphite body seal, Worcester Controls Flowserve Series 82.

Pressure Relief Valves: Relief valves shall be flanged, 150" ANSI, relief pressure of 100 psig, bottom inlet, side discharge, StraVal Model RVC-05-FLG.

Suction Hose: Suction hoses shall be PVC, reinforcement for up to 28" Hg vacuum, temperature range from +10 to +120 degrees F, 25 ft lengths, threaded male connector on one end, swivel female connection on one end, Parker Series 7570 Dynaflex PVC Transparent Suction/Discharge Hose.

Extension Handle: Extension handle shall be aluminum, 1-3/4" diameter, threaded connection (standard concrete bull float extension handle), 6 ft sections, 4 sections required.

Floating Suction Strainer: Floating suction strainer shall be Megator Dolphin Floating Strainer, 1-1/2" hose size.

Sludge Pump: Sludge pump shall be Persitaltic type, EPDM reinforced pump hose, variable speed reversible electric motor, complete with variable speed motor and variable speed drive and forward/reverse controls, ANSI flanged connectors, capable of at least 115 psig and 20 gpm, Bredel Model SPX40.

Carbon Steel Pipe and Fittings: Pipe shall be seamless black carbon steel, sch. 80, per ASTM A106 Grade B, or per ASTM A53. Fittings shall be 3000# class, forged carbon steel, screwed, per ASTM A105.

Carbon Steel Flanges: Flanges shall be 150# ANSI B16.5, RF, Forged CS Weld Neck, Slip-on, Threaded, or SW per ASTM A105 and ASTM A181 Class 70. Gaskets shall be 150#, Grafoil^{R} Gaskets, 1/16" Thick with dimensions per ANSI B16.21. Flange Bolts shall be Chrome-moly stud bolt, Threaded Full Length, per ASTM A193 Grade B7 with Semi-Finished Heavy Hex Nut per ASTM A194 Grade 2H.

Band Clamps: Band clamps shall be heavy duty hose clamps, 300 series stainless steel.

Carbon Steel Plate: Plate shall be hot rolled carbon steel in accordance with ASTM A36.

Riser Clamps: Riser clamps shall be galvanized steel, for supporting and stabilizing vertical pipe runs, Cooper/B-Line B3373 for 3/4" and 1" carbon steel pipes.

Spray Shields: Spray shields shall be installed on all flanges. Shields shall be fabric impregnated with rubber material.

Consolidation Tank System:

Consolidation Tanks: Consolidation tanks are specified in other sections of this specification.

Stainless Steel Pipe & Fittings: Piping shall be schedule 80S seamless corrosion resistant stainless steel, in accordance with ASTM A312 Grade TP304L and ANSI B36.19. Fittings shall be schedule 80, long radius, buttweld, corrosion resistant, stainless steel, in accordance with ASTM A403, WP304-S, ANSI B16.9, and ANSI B36.19.

HDPE Pipe and Fittings: HDPE piping shall be high density polyethylene pipe as manufactured by Chevron Phillips Chemical Company, DriscoPlex 8700 Series, PE 3408 HDPE Pipe, SDR 9.0. Fittings shall be manufactured to match the piping system. All HDPE piping within the encasement pipe shall be one continuous length, with no joints. Flange bolts shall be Chrome-Moly stud bolt, threaded full length, per ASTM A193, Grade B7 with semi-finished heavy Hex Nut per ASTM A194, Grade 2H. HDPE flanges shall include backing rings as recommended by the HDPE manufacturer.

Stainless Steel Flanges: Flanges shall be 150 lb forged corrosion resistant steel, weld neck, raised face with concentric serrated finish, in accordance with ASTM A182 Grade F304L, and ANSI B16.5. Gaskets shall be Grafoil in accordance with ANSI B16.21. Bolting shall be 304 SST Bolts ASTM A193 Gr B8 and Galling Resistant Nitronic 60R Nuts ASTM A194 Gr 8S (UNS S21800).

Stainless Steel Ball Valves: Ball valves shall be 150# Class, body shall be 316 stainless steel ASTM A351 GR. CF8M, flanged ends, full port, 316 SST Ball & Stem, Polyfill ball seat, Graphite body seal, Worcester Controls Flowserve Series 82.

Stainless Steel Tubing: Tubing shall be stainless steel MIL-T-8504 Composition 304 or ASTM A269 TP 304, .035" Wall, Seamless. Fittings shall be stainless steel, ASTM A276 TP316, Swagelok Compression Fittings.

Stainless Steel Globe Valves: Globe valves shall be 150# Class, buttweld ends, OS&Y, bolted bonnet, body and bonnet 316L Stainless Steel, integral seat, castings ASTM A351 Grade CF3M, forgings ASTM A182 Grade F316L, 316 SST Disc, GrafoilR packing, bonnet Gasket GrafoilR.

Stainless Steel 3-Way Valves: 3-way valves shall be 150# Class, body shall be 316 SST, ASTM A351 Gr CF8M, screwed ends, full port, 316 SST ball and stem, Polyfill ball seat, Graphite body seal, V2 porting, Worcester Controls Flowserve 3-way Valve.

Stainless Steel Check Valves: Check valves shall be 150# Class, raised face flanged, or threaded, Swing Type, Bolted Bonnet, Body and Bonnet 316 SST, Integral Seat, castings ASTM A351, Grade CF8M, Forgings ASTM A182, Grade F316, Bonnet Gasket GrafoilR, Disc 316 SST.

Stainless Steel Diaphragm Valves: Diaphragm valves shall be 316 stainless steel, Swagelok Model 6L-LD8-BBXX.

Consolidation Tank System Pumps: Consolidation tank pumps shall be for liquid/slurry service, 160 degree F, specific gravity 1.0, capable of delivering 100 gpm at 120 ft head, and 50 gpm at 140 ft head. Construction materials shall be CD4MCU for casing, box cover, and impeller. Seal chamber shall be taper bore plus with VPE. No external cooling of seal is allowed. Inlet and discharge shall be 150 lb flat faced flanges. Motor shall be 10 hp, 480 VAC, 3 phase, TEFC, 1800 rpm. Pumps shall be Gould Pumps Model 3196 MTX 1.5x3-13.

Consolidation Tank Mixers: Subcontractor shall purchase, deliver, and install three tank mixers, one to be mounted on each consolidation tank. Tank mixers shall be vertical on-center drive mounting, approximately 68 rpm, NEMA 180TC motor, 460 V 3 phase high efficiency TEFC motor, 3.0-inch shaft diameter, 162-inch shaft extension, 316 stainless steel shaft and shaft coupler and impeller, 49-inch diameter impeller type SC3, Wetted parts coated in accordance with Chemineer recommendation for chloride service at 50° C if required, 150# ANSI flange mounting, 8-inch 316 stainless steel raised face flange, 100 psig seal, Chemineer Model 3GTA-5.

HEPA Filter: HEPA filter shall be Flanders/CSC Nipple Connected Nuclear Grade HEPA Filter, 150 lb flat faced flanges, Model Number D-007-C-15-N2-NU-51-00-CC-FU5.

Activated Carbon Filter: GAC Filter shall be Flanders/CSC Model Number AG-GG12-62-A1 impregnated with 2% potassium iodide. Approximately six carbon filters will be used during sparging.

Spray Shields: Spray shields shall be installed on all flanges. Shields shall be fabric material impregnated with rubber material.

Pressure Indicators (Pump Discharge): Pressure indicators on discharge of pumps shall be direct reading, 4" dial, 0 to 200 psig, Dwyer Series 4000 Capsuhelic Differential Pressure Gage, Model 42200S. Gage shall be installed with 316 stainless steel tubing in accordance with ASTM A269 TP 316, 0.035" wall, with stainless steel

Swagelok Compression Fittings in accordance with ASTM A276 TP-316, and isolated with stainless steel tubing block valves. Mount Gage to piping using A-610 Pipe Mounting Kit.

Sample Return Funnel: Funnel shall be 2" stainless steel piping with 2 block valves. Funnel shall consist of an open ended 2" pipe extended 8" above top block valve. No additional supporting is required.

Supernate Spray System:

HDPE Pipe and Fittings: HDPE piping shall be high density polyethylene pipe as manufactured by Chevron Phillips Chemical Company, DriscoPlex 8700 Series, PE 3408 HDPE Pipe, SDR 9.0. Fittings shall be manufactured to match the piping system. All HDPE piping within the encasement pipe shall be one continuous length, with no joints. Flange bolts shall be Chrome-Moly stud bolt, threaded full length, per ASTM A193, Grade B7 with semi-finished heavy Hex Nut per ASTM A194, Grade 2H. HDPE flanges shall include backing rings as recommended by the HDPE manufacturer.

Ball Valves: Ball valves shall be 150# Class, body shall be 316 stainless steel ASTM A351 GR. CF8M, flanged ends, full port, 316 SST Ball & Stem, Polyfill ball seat, Graphite body seal, Worcester Controls Flowserve Series 82.

Pressure Hose: Pressure hose shall be rated for 100 psig working pressure, black EPDM tube and cover, multiple textile pile reinforcement, threaded mpt connector on one end, swivel fpt connection on one end, Parker/Dayco Series 7306M Day-Flo H.D. Water Discharge Hose.

15 Degree Sweeping Nozzles: Nozzles shall be standard flat fan nozzle, 15 degree fan spray angle, 3/4-inch male pipe thread connection, 316 stainless steel, Industrial Mechanical Specialties Limited Model Bete NF400.

Straight Jet Nozzles: Nozzles shall be straight jet nozzle, 0 degree straight jet, ¾ inch male pipe thread connection, 316 stainless steel, Industrial Mechanical Specialties Limited Model Bete NF400.

360 Degree Fan Nozzle: Nozzles shall be flat hollow cone nozzle, 180 degree spray angle, 3/4 inch male pipe thread connection, 316 stainless steel, Industrial Mechanical Specialties Limited Model Bete TF32.

Carbon Steel Pipe & Fittings: Pipe shall be seamless black carbon steel, sch. 80, per ASTM A106 Grade B, or per ASTM A53. Fittings shall be 3000# class, forged carbon steel, screwed, per ASTM A105.

Carbon Steel Flanges: Flanges shall be 150# ANSI B16.5, RF, Forged CS Weld Neck, Slip-on, Threaded, or SW per ASTM A105 and ASTM A181 Class 70.

Gaskets shall be 150#, Grafoil^{R} Gaskets, 1/16" Thick with dimensions per ANSI B16.21. Flange Bolts shall be Chrome-moly stud bolt, Threaded Full Length, per ASTM A193 Grade B7 with Semi-Finished Heavy Hex Nut per ASTM A194 Grade 2H.

Riser Clamps: Riser clamps shall be galvanized steel, for supporting and stabilizing vertical pipe runs, Cooper/B-Line B3373 for 3/4" and 1" carbon steel pipes.

Spray Shields: Spray shields shall be installed on all flanges. Shields shall be fabric material impregnated with rubber material.

Tank Ventilation Systems:

Off-Gas Flex Duct: Off-gas flex duct shall be multi-purpose suction or exhaust hose; neoprene coated polyester fabric, rated to –13 IWG and +24 IWG, NFS-RPS CG21 Flexible Duct/Hose.

Off-Gas Duct Fittings: Fittings shall be stainless steel, aluminum, or PVC pipe matched to off-gas flex duct.

Differential Pressure Gage: Differential pressure gage for HEPA filter shall be direct reading, 4" dial, 0 to 5 inches water gage, Dwyer Series 2000 Magnehelic Differential Pressure Gage, Model 2002. Differential pressure gage for the activated carbon filter shall be a 4" dial, 0 to 3 inches water column, Dwyer Series 2000 Magnehelic Differential Pressure Gage, Model 2003.

PART 3--EXECUTION

GENERAL INSTALLATION OF ALL SYSTEMS:

Shall be in conformity with the applicable requirements of ASME Code B31.3, with the additional requirements for Category M Fluid Service.

The Subcontractor shall field verify all piping dimensions prior to fabrication.

Accessibility: Items such as valves, controls, access doors, specialties, and accessories shall be installed so as to be readily accessible for operation, servicing, maintaining and repairing.

Pipelines: Pipelines shall be installed per the drawings. The Subcontractor shall coordinate the work of all trades involved on this project to prevent interference's. Piping shall not be routed so as to block equipment access panels or to prevent routine maintenance activities.

Piping shall be routed around all electrical components to maintain proper National Electrical Code clearances. The Subcontractor shall notify the Contractor of potential interference issues prior to routing piping.

Pipes shall be full lengths to greatest extent possible. Piping shall be cleaned of dirt, rust, scale, grease and other foreign matter. Piping shall be kept clean as work progresses.

Exposed piping shall be run close to other piping, walls and columns. Runs shall be as close together as possible where under ceilings, slabs, and decks.

Indicating instruments shall be installed for easy reading from operating floors or platforms. If 6 ft or more above floors or platforms, set at 45° angle.

Metallic Pipe and Tube Bends: A minimum bend radius of five (5) pipe diameters shall be used unless otherwise specified. All bends shall be free from wrinkles, kinks, and thin or flat spots. "Out of Roundness" shall not exceed [8% for internal pressure and 3% for external pressure] between the minimum and maximum cross-sectional dimensions. All bends are to be completed prior to beveling, flanging or cutting to length.

PIPE JOINTS AND CONNECTIONS:

Flanged Pipe Joints: Flanged pipe joints shall be in accordance with ASME B31.3. Torque values for flange bolts shall be in accordance with the gasket manufacturers written recommendations for the size and service conditions and ASME Section VIII, Division 1, App. 2.

All flanged pipe joints shall be covered with a spray shield.

Welded Pipe Joints: Welded joints shall be made in accordance with Welding Section 15024 of these specifications.

Tube Joints: Tube joints shall be in accordance with ASME B31.3 and the fitting manufacturers written instructions.

HDPE Joints: HDPE joints shall be in accordance with the pipe and fitting manufacturers written instructions.

PIPE IDENTIFICATION AND VALVE TAGS:

After installation, all pipelines shall be identified by tagging with their line number or designation as shown on the drawings. The tag shall be fabricated from 24 gage, 3/4 in. wide, 3 in. long, AISI Type 303 or 304 stainless steel metal strip with 3/16 in. high letters stamped in the metal surface. Tagging shall be done at 20-ft intervals and at least once in each cell. Any pipes entering or leaving a cell shall be tagged at the sleeve connections on both sides of the penetrations. The tags shall be tied to the line with AISI Type 304 annealed stainless steel bead chain with stainless steel catches. All tags must be free from sharp edges.

Color Coding: All pipelines shall be color coded and identified using full English text names according to the following list:

PIPE CONTENT IDENTIFICATION LIST

PIPE CONTENT AND LABEL TEXT	COLOR*
OFF GAS, VESSEL	Yellow/Black
WASTE, RADIOACTIVE	Yellow/Magenta

*Background Color/Letter Color

Lettering shall be as specified below:

Size of Labels

Outside Diameter of Pipe or Covering (in.)	Width of Color Band	Size of Legend Letters
3/4 to 1 1/4	8	1/2
1 1/2 to 2	8	3/4

(All dimensions are given in inches.)

EQUIPMENT, FIXTURES, ETC.:

Equipment shall be set in place, aligned, connected per the applicable drawing, and made ready for operation. Connections and required safety devices shall be installed. Initial lubrication shall be provided. Controls shall be set for efficient, stable operation.

Fixtures shall be installed and supported per the applicable drawings in a safe, rigid, neat, and orderly manner. They shall be free from undue stresses and made suitable for normal use. Wall mounted supports shall be of the type as recommended by the manufacturer of the fixture used.

All of the above shall be protected from damage during and after installation. At completion, work shall be free from tool marks, discolorations, cracks, scratches, chips and other defects.

HANGERS, SUPPORTS AND FASTENERS:

Pipe hangers shall be fabricated and installed as shown on the Subcontract drawings. Where interferences occur with hanger placement, the Subcontractor shall submit an alternative position to the Contractor for approval.

INSTALLATION OF INDIVIDUAL SYSTEMS:

The installation of each system shall comply with the rules contained in the "GENERAL INSTALLATION OF ALL SYSTEMS" section. All welding and welding inspection shall

be in accordance with the appropriate procedure contained in Welding Section 15024 of this specification.

Encased Piping: All encased piping shall be continuous lengths of pipe, with no joints. Encased pipe shall be installed inside the encasement pipe in the field. Encasement pipe will be open ended at both ends, and joints shall be minimized.

FIELD QUALITY CONTROL:

Testing: Test procedures and reports shall be submitted as vendor data submittals. Testing shall be in accordance with the general requirements of ASME B31.3 Paragraph 345, and shall include the following:

HDPE Pressure Piping: All HDPE pressure piping (including sludge pump to consolidation tanks and supernate return piping to spray nozzles) shall be hydrostatic leak tested in accordance with ASME B31.3 Paragraph 345.4. Test pressure shall be 200 psig (+10 psig –0 psig). Test medium shall be plant water. Water shall be pumped into the supernate collection tank or as directed by the Contractor. Consolidation tanks shall NOT be pressurized.

Sludge Suction Piping and Hoses: All sludge suction piping (including all piping upstream of the sludge pump) shall be hydrostatic leak tested in accordance with ASME B31.3 Paragraph 345.4. Test pressure shall be 50 psig (+5 psig –0 psig). Test medium shall be plant water. Water shall be pumped into the supernate collection tank or as directed by the Contractor.

Stainless Steel Piping: All stainless steel piping (including consolidation tank suction lines to pumps, pumps, and all consolidation tank pump discharge piping) shall be hydrostatic leak tested in accordance with ASME B31.3 Paragraph 345.4. Test pressure shall be 150 psig (+10 psig –0 psig). Test medium shall be plant water. Water shall be disposed of as directed by the Contractor. Consolidation tanks shall NOT be pressurized.

HDPE Tank Vent Piping: All HDPE tank vent piping from the consolidation tanks through the HEPA filter shall be pneumatic leak tested in accordance with ASME B31.3 Paragraph 345.5. Test pressure shall be 15 psig (+5 psig –0 psig). Test medium shall be air. Consolidation tanks shall NOT be pressurized.

Contractor Inspections: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

CLEANING AND PURGING:

Precautions shall be taken to maintain cleanliness of materials and equipment during delivery, storage and installation. Piping, valves, fittings, and equipment shall be visually free from grease, cutting oils, loose particles, ships, or other foreign matter.

All piping systems shall be flushed or purged as follows:

All piping shall be flushed with water for 10 minutes minimum. On-site, water source and disposal shall be as directed by the Contractor's Representative.

END OF SECTION 15203

SECTION 15800--HEATING SYSTEM

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish and install all equipment, material, supplies, and perform all work and operations necessary for installation of the Heating System as specified herein.

Section Includes: Work includes, but is not limited to:

Furnish and install portable electric heaters as shown on the subcontract drawings and as specified herein

Test the complete installation including controls to verify proper function and operation as specified herein

Coordinate the installation of the heating system with the electrical sections of this specification and other trades.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	National Electric Code
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems

SYSTEM DESCRIPTION:

The heating system consists of eight (8) portable electric heaters located approximately as shown on the HV drawings.

SUBMITTALS:

Submittals include but are not limited to the following:

Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

See Section 01300, Submittals and Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Installer: Firms with successful installation experience on projects with heating systems similar to those required for this project.

Comply with ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) rating and installation recommendations, except as otherwise indicated.

Comply with NFPA 90B.

Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

Comply with NFPA 70 - National Electrical Code.

Manufacturers: Firms regularly engaged in manufacture of heating systems of types and sizes required and whose products have been in satisfactory use in similar service. Equipment shall be as specified or approved equal.

DELIVERY, STORAGE, AND HANDLING:

Deliver: Deliver heating system and other equipment furnished in this section in factory wrapped containers. Coordinate delivery of units in sufficient time to allow movement into/onto structure.

Store: Store heating and other equipment furnished in this section in clean dry space; protect from dirt, fumes, water, and construction traffic.

Handle: Handle equipment furnished in this section carefully to avoid damage to components and finish. Protect finish during installation. Do not install damaged equipment; replace damaged parts or equipment and remove them from project site. Handle units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

PART 2--PRODUCTS

MANUFACTURERS: Firms regularly engaged in manufacture of heating systems of types and sizes required and whose products have been in satisfactory use in similar service. Equipment shall be as specified on Subcontract drawings.

EQUIPMENT:

Portable Electric Heaters: Portable electric heaters shall be complete with thermostatic control with a full off position, a fan only position, and an adjustable temperature range setting. Heaters shall be complete with controls and control voltage transformer as required. Heaters shall be complete with magnetic contactor for single point field wiring connection. Heaters shall be 20 kW capacity, 480 VAC, 3 phase. Heaters shall be Chromalox Model DRA Portable Spot Industrial Salamander Blower Heater.

PART 3--EXECUTION

INSTALLATION/APPLICATION/ERECTION:

Protective Coatings: After completion of the installations and before testing or initial operation of the equipment all special protective temporary coatings, covers, etc., which were applied for protection during shipment and storage, and which did not require removal for assembly and/or installation shall be removed.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: The Subcontractor shall start the heating system and ensure that the system is operating as designed, with proper heat output and air flow. Certified TAB service is not required for this system.

Subcontractor Inspection: The work shall be inspected and tested by the Subcontractor to verify compliance with the Subcontract drawings and specifications.

Contractor Surveillance: Surveillance will be performed by the Contractor to verify compliance of the work to the Subcontract drawings and specifications.

END OF SECTION 15800

SECTION 16000--ELECTRICAL GENERAL PROVISIONS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide, install, terminate, and test all the systems as described in the specification and shown on the drawings to make complete and operational electrical systems.

Section Includes, but is not limited to:

1. Power distribution including poles, transformers, feeders, branch circuits, and panels
2. Instrumentation
3. Normal power distribution
4. Power system grounding.

Related Sections:

02200	Earthwork
15400	Piping and Plumbing Systems (water heaters, drinking fountains)
15801	Air Distribution System
15803	HEPA Filter Housings

REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. Unless otherwise indicated, use the latest edition in effect as of the date of these specifications.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C-2	National Electrical Safety Code

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-101	Life Safety Code

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Subpart S	OSHA Electrical Safety

FACTORY MUTUAL

NATIONAL RECOGNIZED TESTING LABORATORIES (NRTL)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

CANADIAN STANDARDS ASSOCIATION (CSA)

UNDERWRITERS' LABORATORIES, INC. (UL)

UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with the following codes and standards, except as modified herein:

Underwriters Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment or devices shall be listed and/or labeled by UL or other nationally recognized testing laboratories such as the CSA.

Completed electrical system shall conform to applicable provisions of the Special Conditions, the Technical Specification, and the subcontract drawings.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials, equipment and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Safety Code (NESC), National Electrical Code (NEC), and Occupational Safety and Health Administration (OSHA). All modifications required by these codes, rules, regulations, and authorities, shall be made by the Subcontractor without additional charge to the Contractor. Temporary installations as described in Article 527, of NFPA 70 and indicated on the drawings shall be allowed on this project.

MANUFACTURERS:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

MATERIALS:

Except as otherwise indicated, furnish new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

ENVIRONMENTAL CONDITIONS:

Climatic and Geographic Site Conditions:

Site Elevation	4,917 feet
Barometric Pressure	12.27 psia
Relative Humidity	90% max. at 30°F (–1.1°C) dry bulb
	15% min. at 60°F (+15.5°C) dry bulb
Temperature	+104°F (+40°C) max.
	-40°F (-40°C) min.
Snow Load	30 psf
Wind Forces	80 mph Exposure Class “C”

NEMA 3R, 4, and 4X, enclosures will be provided for all outdoor equipment and NEMA 1, 12, or 3R for all indoor equipment unless noted otherwise on drawings.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches. See Section 16195--Electrical Identification, for labeling requirements.

PART 3--EXECUTION

SEQUENCING/SCHEDULING:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work and in its

interface with other work, including utilities structural, and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance. Temporary installations shall conform to the requirements of Article 527, NFPA 70 (NEC).

Locate operating and control equipment properly to provide easy access, and working clearance in accordance with the NEC.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of electrical equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer. If manufacturer has no recommended torque value, tighten as per UL 486A.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: Upon completing installation of all systems and equipment, but prior to project close out, the Subcontractor shall conduct an operational test of all equipment, controls and devices installed or modified by the Subcontractor. The operational test shall include performance tests required by the NEC. All equipment shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

The Subcontractor shall test all devices in the presence of the Contractor's Representative. Subcontractor shall coordinate testing with the Contractor and schedule testing a minimum of 2 weeks in advance of the test. The Subcontractor shall inform the Contractor in writing of the scheduled test to allow the Contractor to designate the Contractor's Representative. This operational testing is in addition to testing required in separate sections of this specification.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16000

SECTION 16109--SWITCHES, RECEPTACLES AND WALL PLATES

PART 1--GENERAL

SUMMARY:

Subcontractor shall provide and install switches and receptacles of sizes, ratings, materials and types as shown on the drawings.

Section Includes, but is not limited to:

Installation of new devices as detailed on the drawings.

Related Sections:

16000 Electrical General Provisions

REFERENCES:

See the list of general references in Section 16000.

SUBMITTALS:

Submittals include, but are not limited to the following:

1. Receptacle test procedure
2. Receptacle test results.

See Section 01300, Submittals, other electrical sections for additional submittal requirements.

PART 2--PRODUCTS

MATERIALS:

Switches: Provide specification grade, general-duty flush or surface mounted single-pole toggle switches, grounding type with green equipment ground screw, 20 ampere, 120 VAC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, and side-wired screw terminals. Switches shall be single-pole (double-pole), (3 way) or (4 way) as indicated by the drawing symbols as shown on the drawings. Where more than one switch is shown at an outlet, switches shall be installed under a gang plate in an order appropriate to outlet location.

Switch color shall be Ivory.

Acceptable manufacturers and models include the following:

Hubble	Model 1121 (single-pole)
Hubble	Model 1122 (double-pole)
Hubble	Model 1123 (3 way)
Hubble	Model 1124 (4 way)
Leviton	Model CS120-2 (single-pole)
Leviton	Model CS220-2 (double-pole)
Leviton	Model CS320-2 (3 way)
Leviton	Model CS420-2 (4 way)
Pass & Seymour	Model 20AC1 (single-pole)
Pass & Seymour	Model 20AC2 (double-pole)
Pass & Seymour	Model 20AC3 (3 way)
Pass & Seymour	Model 20AC4 (4 way)

Receptacles:

General-Duty Duplex: Provide specification grade, duplex general-duty, flush or surface mounted receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 125 V, with metal plaster ears, side wiring, NEMA Configuration 5-20R unless otherwise indicated on the drawings. Acceptable manufacturers and models include the following:

Hubble	Model 5342
Daniel Woodhead	Model 5352DW
Pass & Seymour	Model 5342

Ground Fault Circuit Interrupter (GFCI) Receptacle: Provide commercial grade, duplex general duty ground fault circuit interrupter receptacles, 2-pole 3-wire grounding, feed-through type, flush or surface mounted, capable of protecting connected downstream receptacles on single circuit, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 V, 60 Hz; equipped with 20 ampere plug configuration NEMA 5-20R. Acceptable manufacturers and models include the following:

Hubble	Model 5352A
Daniel Woodhead	Model 5352GF
Pass & Seymour	Model 2091

Power Receptacles: Receptacles and plugs larger than 20 amps, 1 phase 208Y/120 volts and 480Y/277 volts shall be as specified on the drawings

Wall Plates: Provide single switch and duplex outlet wall plates for wiring devices, with ganging and cutouts as indicated, provide with metal screws for securing plates to devices,

screw heads finished to match plate finish, and with plates possessing the following additional construction features:

Material and Finish/Indoor Use: Cover plates shall be Ivory color unbreakable nylon.

Material and Finish/Outdoor Use: Receptacle covers installed outdoors shall be rain tight with a NEMA 3R rating. Receptacle covers shall maintain this rating even when equipment is plugged in. This shall be accomplished by using flip lids or similar Cover shall close automatically when released. All components of receptacle cover shall be made of corrosion resistant materials.

PART 3--EXECUTION

INSTALLATION:

Install receptacles, switches and wall plates where indicated on the drawings in accordance with recognized industry installation practices.

Receptacles to be mounted 18 in. from floor unless shown otherwise on the drawings. Switches to be mounted 48 in. from floor unless shown otherwise on the drawings.

Coordinate with other work including electrical raceway and equipment installation work, as necessary to interface installation of wiring and devices with other work.

Install receptacles and switches only in electrical boxes which are clean and free from building materials and debris.

LABELING:

Label all covers and plates. Install labels per Section 16195--Electrical Identification.

FIELD QUALITY CONTROL:

Subcontractor Supplied Inspection and Tests: The Subcontractor or his agents shall perform the following:

1. Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings
2. Subsequent to hooking-up cables/wires and devices, energize circuitry and demonstrate functioning in accordance with requirements
3. Each receptacle shall be tested with a portable receptacle circuit tester to test for polarity, grounds, and opens.

Subcontractor shall furnish a data sheet, listing room numbers or area and number of receptacle tested and test results.

Circuit testers shall be approved by the Contractor's Representative prior to use.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16109

SECTION 16110--ELECTRICAL RACEWAYS

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide and install electrical raceways for power and controls systems.

Section Includes, but is not limited to:

Provide and install electrical raceways of types, grades, and sizes specified on the drawings

Provide complete assembly of raceway including, but not necessarily limited to, couplings, elbows, adapters, hold-down straps, and other components and accessories as needed for a complete system

Coordinate as necessary to integrate installation of electrical raceways and components with other work

Label all conduits.

Related Sections:

16000 Electrical Sections

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. See the list of general electrical references in Section 16000.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 Pipe Threads, General Purpose (Inch)

METAL FRAMING MANUFACTURER ASSOCIATION (MFMA)

MFMA-1 Metal Framing Channel

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for submittal requirements.

PART 2--PRODUCTS

MATERIALS:

Conduit:

Metal Conduit: Rigid Metal Conduit (RMC) or Intermediate Metal Conduit (IMC) shall be used for all conductors in damp or wet locations. All conduit shall be UL approved, **3/4**-in. minimum unless shown otherwise on the drawings.

Fittings: Conduit fittings for rigid conduit (RMC or IMC) shall be rust-resistant cast steel. Conduit fittings for EMT shall be steel, rain-tight compression type.

Junction Boxes: All junction boxes shall be galvanized unless shown otherwise. Small junction boxes (4-11/16 in. square and smaller) shall be stamped from one piece of sheet steel or welded construction and shall be galvanized. Where required to be weatherproof, small junction boxes shall be die-cast aluminum rated for wet locations. Enclosures larger than 12 in. x 12 in. shall be supported at each corner.

Framing Channel for Conduit/Box Support: Where indicated on the drawings or as required by the NEC, bolted framing channel shall be used to support conduits and electrical boxes. Galvanized steel channel shall be used in all outdoor/exterior locations and epoxy painted channel in all interior locations. The minimum size bolt used for bolting framing channel together for a support structure shall be 3/8 inch. The exposed ends of all framing channel shall have a protective cap installed. Sizes shall be as detailed on the drawings. All framing channels shall be made of channel, fittings, and hardware as defined in MFMA-1 and shall be minimum 14-gauge steel.

PART 3--EXECUTION

INSTALLATION:

Install and support conduit as indicated on the drawings in accordance with manufacturer's written instructions, applicable requirements of NEC, and National Electrical Contractors Association's "Standard of Installation". Comply with recognized industry practices to ensure that products serve intended functions.

Where mounting channel is used, all exposed ends shall be capped. All above grade, exposed conduit shall be anchored to mounting channels a minimum of 12 inches long.

Rigid conduit (RMC and IMC) joints shall be cut square, reamed smooth in accordance with the NEC requirements. Joints shall be threaded and drawn up wrench tight in accordance with ASME B1.20.1. Bends or offsets shall be made with standard conduit bending dies that will NOT injure or flatten the pipe.

Rigid conduit terminating at cabinets and boxes shall be rigidly secured with locknuts inside and outside. EMT conduit terminating at cabinets and boxes shall be bonded per Article 250.97.

Male threads on exterior runs of galvanized steel conduits shall be thoroughly coated with a conducting sealing media such as petroleum base products. No red lead shall be used on any conduit joint.

Conduit Indentification: Label conduits per Section 16195--Electrical Identification.

FIELD QUALITY CONTROL TESTING:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform visual inspections to determine that equipment installation conforms to the NEC, these specifications, and the drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work with the drawings and specifications.

END OF SECTION 16110

SECTION 16120--CABLE, WIRE, CONNECTORS AND MISCELLANEOUS DEVICES

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish, install, and terminate all cables, conductors, and devices to make complete and operational systems for this project.

Section Includes, but is NOT limited to the following:

Provide and install cables, wires, and wiring connectors of sizes, ratings, materials and types as specified on the drawings.

Related Sections: See other related sections for specific cables, wire, labels, and testing requirements.

16000 Electrical General Provisions
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this specification to the extent designated. Unless otherwise indicated, use the latest edition in effect as of the date of this specification.

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS INC. (IEEE)

IEEE 576	Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in the Petroleum and Chemical Industry
IEEE 1202	Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

NATIONAL ELECTRICAL CABLE ASSOCIATION (NECA)

Standard for Installation Practices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

UNDERWRITERS LABORATORIES, INC. (UL)

UL 1581	Electrical Wires, Cables, and Flexible Cords

SUBMITTALS:

Submittals include, but are not limited to the following:

1. Megger test procedure and test results
2. Continuity test procedure and test results.

See Section 01300, Submittals and the Vendor Data Schedule, for additional submittal requirements.

PART 2--PRODUCTS

WIRING MATERIALS, 600 V:

Conductors shall be stranded for all sizes of wire and cable.

Conductors shall be copper for all sizes.

Wire insulation shall be Type THHN/THWN or XHHW for all 600 V conductors unless otherwise noted.

Temporary installations as described in Article 527, of NFPA 70 and indicated on the drawings shall be allowed on this project. All flexible cords and cables shall be listed as extra hard usage as indicated in Table 400.4 on NFPA 70 or as indicated on the drawings.

Minimum size of power conductors shall be No. 14.

Wiring shall be color-coded as indicated in the table below:

Conductor Code Color

Conductor	208/120 Volts*	480/277 Volts	240/120 Volts*
Phase A	Black	Yellow	Black
Phase B	Red	Orange	Red
Phase C	Blue	Brown	
Neutral	White	Gray	White
Ground	Green	Green	Green
DC +	Red**		
DC -	Black**		

* For new circuits installed in existing panels only, black may be used for any phase conductor, white for neutral and green for ground.

Use appropriate colors of plastic tape or sleeves to identify conductors larger than #10 AWG NOT furnished with colored insulation. Yellow phase tape shall consist of two separate bands at each application point to avoid confusion with white, gray, or orange after aging. All wire markers and clear heat-shrink sleeving shall cover phase tape.

Wire #10 AWG and smaller shall be furnished with continuous colored insulation for all power, neutral and ground conductors when multiple circuits are installed to identify the phase connected to, neutral, or equipment ground wiring. Bare copper conductors shall only be used for ground conductors as shown on the drawings.

Portable cords and cables shall not require identification as indicated above. For those parts of the circuit supplied by portable cord the manufactures color code in the conductors is acceptable.

CONNECTORS:

All connections shall be tightened to the manufacturer's published torque values. Where manufacturer does not specify torque requirements, connections shall be torqued to values specified in UL 486A.

Connectors shall only be used as specified by manufacturer.

Spring type pressure connectors, such as "Scotchlock," shall be used for splicing No. 8 AWG and smaller.

Splitbolt and/or lug type connectors such as "Burndy" shall be used for splicing No. 6 AWG and larger.

Scotch mastic pads and two layers of half wrapped electrical tape shall be installed over all splitbolt connectors.

Where underground splices are made to repair damaged power cables, Scotchcast Power Cable Splice Ket #82-A series shall be used.

Crimp on spade or ring-tongue lug connectors shall be used for connection to terminal boards such as "Stakon."

Wire/Device Identification: See Section 16195--Electrical Identification.

PART 3--EXECUTION

INSTALLATION:

General: Install electrical cable, wire, and connectors as follows:

1. As specified on the drawings

2. As specified in manufacturer's written instructions
3. as specified in applicable requirements of NEC and NECA's "Standard of Installation"
4. In accordance with recognized industry practices to ensure products serve their intended functions.

Coordinate cable and wire installation work with electrical raceway and equipment installation work as necessary for proper interface.

Bundle and form wires inside wireways, panel boards, control panels, junction boxes, etc. to clear pinch points, hinges, screws and clamps associated with the enclosure cover.

Pull conductors at the same time if more than one is being installed in a raceway. Do NOT exceed the conductor manufacturers recommended pulling tension.

Use pulling compound or lubricant where necessary (compound must NOT cause the conductor or insulation to deteriorate.)

Use pulling methods including fish tape, cable, or rope that cannot damage raceway. Any conductors that require mechanical assistance in pulling shall be installed in accordance with IEEE 576. Pulling calculations shall be performed on all conductors sized 1/0 AWG and larger. Cable pull sheets shall be submitted for review prior to pulling.

The practice of "pull byes" shall NOT be used unless specifically approved on a case by case basis by the Contractor. The "pull by" schedule shall be approved prior to the pull.

Keep conductor splices to a minimum.

Install splices and taps that have a mechanical strength and insulation rating equivalent to, or better than, the conductor.

Use splice and tap connectors that are compatible with conductor material.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing:

Meggering: Prior to terminating, test any cable or wire 25 ft. or more in length for insulation resistance using the megger (500 V megger for 300 V insulation and 1000 V megger for 600 V insulation). Any wire identified with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating process. List the tested conductors on the required Test Data Submittal Sheet. An alternate megger test voltage can be used as recommended by the manufacturer for the specific cable or wiring.

Electrical Continuity: Complete an electrical continuity test on each conductor as follows:

1. Before termination of conductors to terminals or devices
2. After the conductor connectors have been installed
3. After the conductors have been labeled.

Use a battery-powered buzzer or calibrated ohmmeter to determine if all power, control, grounding, and other conductors are properly installed and identified. List all conductors that were tested on the required Test Data Submittal Sheets. The Subcontractor is required to provide the Test Data Submittal Sheets.

Contractor Supplied Inspection and Testing: The Contractor's Representative shall witness the installation of any cables installed via the "pull by" method.

Wire and cables shall be checked for proper termination and termination tightness. The Contractor's Representative shall witness torquing of all connections unless indicated otherwise.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16120

SECTION 16124--INSULATED MEDIUM VOLTAGE CABLE AND CONNECTORS

PART 1--GENERAL

SUMMARY:

This section includes single and multiple conductor cables, cable splices, terminations and accessories for medium voltage cables.

Section Includes, but is not limited to:

Provide and install 15 kV cable and connectors of the types specified herein and as shown on the drawings.

Related Sections:

16000 Electrical General Provisions
16110 Electrical Raceways
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. Unless otherwise indicated use the latest edition in effect as of the date of these specifications.

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS INC. (IEEE)

IEEE 48	IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations
IEEE 386	Separable Insulated Connectors for Power Distribution Systems above 600V
IEEE 400	Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field
IEEE 404	Standard for Power Cable Joints
IEEE 592	Standard for Exposed Semi Conducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors

UNDERWRITERS LABORATORIES (UL)

UL 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 1072	Medium Voltage Power Cables

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC8	Ethylene - Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (1CEA S-68-516)
NEMA WC26	Wire and Cable Packaging Standard

SUBMITTALS:

The Subcontractor shall provide a completed cable pull sheet to the Contractor's Representative for signature prior to cable pulling. Signed cable pull sheets or copies thereof shall be in the possession of the cable installer during each cable pulling.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

NFPA 70, National Electrical Code
National Electrical Safety Code

Cables and connectors shall each be listed and labeled by UL.

Single Source Responsibility: All medium voltage cable shall be the product of a single manufacturer.

Installer Qualifications: Engage an experienced Installer of medium-voltage electrical cable to perform the installation specified in this section. In addition, for the specific work of cable splicing and terminating, engage Installers who are experienced in cable splices for the specific types of cable and cable accessories specified in this Section. Installers shall have a minimum of three years documented experience.

DELIVERY, STORAGE, AND HANDLING:

Deliver medium-voltage cable on factory reels conforming to NEMA WC26. Store cable reels on an elevated platform in a dry location. Cable ends shall be checked for water tight seals. Reel ends of cables shall be immediately resealed after cutting to eliminate intrusion of moisture. Cable jackets subject to ultra-violet degradation shall be stored indoors.

PART 2--PRODUCTS

MATERIALS:

MEDIUM-VOLTAGE CABLE:

General: Cable shall be single- and multi conductor types, with types and size as indicated on the drawings, and conforming to UL Standard 1072. Approved cable manufacturers are Okonite Co., Rome Cable Co., and Brand-Rex Cable Systems (Brintec Corp.).

Cable Type MV-105: Cable Type MV-105 shall be EPR insulated and shall conform to NEMA Standard WC8 (1CEA S-68-516) unless otherwise shown on the drawings.

Conductors: Class B stranded, annealed copper.

Cable Jacket: Polyvinyl Chloride.

Metallic Shielding: Copper shielding tape, helically applied over semi conducting insulating shield.

Cable Voltage Ratings: 15 kV, phase-to-phase as shown on the drawings and in accordance with the referenced standard.

Insulation Thickness: Corresponding to 133% insulation level in accordance with the referenced standard unless shown otherwise on the drawings.

Circuit Identification: Color-coded tape (Black-Phase A, Red-Phase B, Blue-Phase C) shall be applied under the metallic shielding for 15 KV multi conductor cable in all pull boxes. Cable circuit numbers shall identify the cable at no less then every 100 ft. of exposed cable and at each entry to equipment.

SPLICING AND TERMINATING PRODUCTS:

General: Comply with IEEE 48, IEEE 400, IEEE 404, IEEE 592, and UL 486A.

Types: Compatible with the cable materials.

Connectors: Compression type as recommended by cable or splicing kit manufacturer for the application.

Splicing and Terminating Kits: As recommended by the manufacturer in writing for the specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain all components required for a complete splice or termination including detailed instructions and shall provide insulation equivalent to the insulation class of the cable it connects. Splices shall be made with standard splicing kits and shall be of the following manufacturers: Thomas and Betts, Raychem Corp., or 3M Company.

Conductor Terminations, General: Comply with Class 1, 2, or 3 of IEEE Standard 48, as indicated. Insulation class shall be equivalent to that of the cable upon which they are installed. Terminations for shielded cables shall include a shield-grounding strap. Class 2 terminations and non-shielded cable terminations shall include an effective moisture seal for the end of the insulation whether or not this item is included in terminations kits. Seal shall be cold shrink rubber sleeve, or heat shrink sleeve as recommended by the kit manufacturer. Termination kits shall be performance tested for compliance with IEEE Standard 48 and shall be of the following types:

Class 1 Termination for Outdoor Shielded Cable: Cold-shrinkable type with UV stability and tracking and erosion resistance, plus Hi-K stress control. Termination shall be skirted. Specified compression-type connector shall be supplied.

Separable Insulated Connectors: Modular system, complying with IEEE Standard 386, shall consist of disconnecting, single-pole cable terminators and matching stationary, plug-in, dead-front terminals. System components shall be designed for the system voltage and for sealing against moisture and shall conform to the following:

Cable Termination at Equipment (i.e. transformers or switchgear): Elbow-type load break terminators that mate with bushing terminals in the equipment.

Load-Break Cable Terminators: Elbow-type units with 200 ampere load make/break and continuous current rating as shown on the drawings. Each terminator shall be coordinated with insulation diameter and conductor size and material of cable being terminated. Terminator body shall have capacitive coupled test point. Load Break elbows shall be sized to mate with existing Cable Termination at Equipment (i.e. transformers or switchgear): as shown on drawings.

PART 3--EXECUTION

EXAMINATION:

Examine raceways, junction boxes, and other cable installation locations for cleanliness of raceways, minimum bending radii of cables, and conditions affecting performance of cable installation. Pull a mandrel through raceways to check for raceway blockages and cleanliness. Do not proceed with cable installation until satisfactory conditions have been achieved.

INSTALLATION:

General: Install cable accessory items in accordance with manufacturer's written instructions and as indicated. Do not exceed manufacturer's approved maximum pulling tensions and sidewall pressure values.

INSTALLATION OF CABLES:

Install cable in accordance with manufacturers written instructions and at locations shown on the drawings. Cables installations which deviate from the drawings i.e., pull lengths or pull direction etc. shall be calculated and submitted by the Subcontractor for written approval.

Pull Conductors Simultaneously: Conductors in the same raceway shall be pulled simultaneously. Use UL-listed and manufacturer-approved pulling compound or lubricant where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values for multi conductor installation. Where only single cable maximum values are provided by the manufacturer use only 70% of the maximum tension and sidewall pressure value.

Cable Pull Sheets: Each individual cable installation shall be identified on a "Cable Pull Sheet(s)." The pull sheet shall completely identify the cable type, manufacturer's reel number, length, number and location of splices, type pulling rope, type lubricant, type cable attachment, along with a sketch of the pull.

Use Pulling Means: Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches as the pulling attachment to cable.

Install Exposed Cable: Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

INSTALLATION OF TERMINATIONS:

Install Terminations: Install terminations at ends of conductors and seal multi conductor cable ends with standard kits. Conform to manufacturers written instructions. Comply with classes of terminations indicated. Cables not terminated within 3 hours shall be sealed to eliminate the entrance of moisture.

Tighten Electrical Connectors and Terminals: Tighten electrical connectors and terminals in accordance with manufacturer's torquing requirements. If requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

INSTALLATION OF CABLE ACCESSORIES:

Arc-proofing: Arc-proofing shall be applied to medium voltage cables as indicated or where not protected by conduit, or termination materials. Apply arc-proofing tape as recommended by the manufacturer.

GROUNDING:

Ground shields of shielded cable at terminations, splices, and separable insulation connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturers written instructions.

IDENTIFICATION:

Identify cable in accordance with Section 16195, Electrical Identification.

FIELD QUALITY CONTROL:

Subcontractor Supplied Inspection and Testing:

Test Objectives: To ensure cable installation, including cable accessories, is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.

Procedures: Comply with International Electrical Testing Association (NETA) standard, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems", Section 7.3.2, Cables, Medium Voltage and IEEE 400. Upon satisfactory completion of tests, attach a label identified by cable pull sheet number to the tested components.

Report Form: Test reports shall be identified by reference to individual cable pull sheet(s).

Tests: After the termination kits are installed, but prior to terminating at the equipment, the Subcontractor will perform cable testing. Coordinate the testing with the Operating Contractors Power Management group.

Test Report: Test reports shall be contained with and become part of the cable pull sheet. Cable pull sheets shall be in the possession of the cable tester at the test site during each test.

The Subcontractor shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Subcontractor shall submit written reports to the Contractor Representative.

The Contractor's Representative, shall be informed of all cable test a minimum of 72 hrs in advanced of any cable testing. The Contractor Representative shall witness or waive the right to witness field tests and inspect the installation to determine compliance with the specifications and drawings.

If any conductor in a pull group fails the test then all conductors in that pull group shall be removed and replaced at the Subcontractors expense.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16124

SECTION 16155--MOTOR STARTERS (<600 VAC)

PART 1--GENERAL

SUMMARY:

Subcontractor shall provide and install motor starters of types, grades, and sizes as specified on the drawings or in this specification. The Subcontractor is required to provide complete motor controller assemblies.

Subcontractor shall provide control, wiring, feeder, and installation of overload heaters. Subcontractor shall also provide and install wiring to the motor terminal box and connect the motor for the appropriate voltage and speed in accordance with the manufacturer's instructions. Subcontractor shall also verify that the motor rotation direction is correct.

Section Includes, but is not limited to:

1. Enclosure
2. Circuit breakers
3. Motor Circuit Protectors (MCP's), or fuses
4. Overload heaters
5. Control transformer if needed
6. Control switching
7. Additional components and accessories as needed for a complete motor controller system.

Related Sections:

16000 Electrical General Provisions
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

NATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA 7.16.1.1

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA-70 National Electrical Code (NEC)

SUBMITTALS:

Submittals include, but are not limited to the following:

1. Operation and Maintenance Manual
2. NETA Certification of Inspector/Technician or Professional Engineer of correct discipline
3. CC Test Report.

Refer to Section 01300, Submittals and the Vendor Data Schedule, for additional submittal requirements.

PART 2--PRODUCTS

Underwriters' Laboratories (UL): All materials, appliances, equipment and devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment and devices shall be listed and/or labeled by UL or approved NRTL.

MATERIALS:

Motor Starters: Provide motor starters and auxiliary components of types, sizes, ratings and electrical characteristics indicated on the drawings that; (a) comply with manufacturer's standard materials, design, and construction in the published product documentation; and (b) as required for a complete installation.

General Motor Starter Requirements: Motor starters shall have a quick-make / quick-break operating devise. Operating handles or buttons shall clearly indicate whether the unit is ON, OFF, or TRIPPED. Starters shall be mounted in a metal enclosure having the appropriate size and National Electrical Manufacturers Association (NEMA) rating as indicated on the drawings. Added accessories, such as push buttons or pilot lights, shall not alter the NEMA rating of the enclosure.

AC Fractional HP-Manual Starters: Provide manual single-phase fractional HP motor starters of types, ratings, and electrical characteristics as specified on the drawings. Equip with thermal overload relay and properly sized overload heater for protection at the rated voltage and current.

All control wiring shall be #14 AWG minimum.

ELECTRO-MECHANICAL MOTOR STARTERS:

Motor Starters Larger than 1 HP (Three Phase): Provide combination motor starters of types, ratings, and electrical characteristics as specified on the drawing.

The overload relay shall have a manual reset button and the current overload adjustment shall be set according to the NEC requirements established in Article 430.

Combination Reversing and Non-reversing Starters: Provide full-voltage, alternating current, combination reversing or non-reversing starters of the NEMA size and voltage with the number of poles indicted on the drawings. The combination starters shall have a MCP, of the amperage rating as indicated on the specific drawings or in this specification. MCP's and circuit breakers shall have a minimum rating of 20,000 amp (AIC) symmetrical interrupting capacity.

Equip starters with a steel mounting plate, a molded arc hood, and overload relay protection device that will detect and trip under any of the following condition:

Over-current.

The device shall have a manual reset and the current overload adjustment shall be set according to the NEC requirements established in Article 430.

Provide a mechanism for locking the operating handle in the OFF position.

Provide control transformer with a 480 VAC fused primary 2 fuses and a 120 VAC fused and grounded secondary. Unless otherwise indicated, provide control transformer with adequate VA capacity to operate connected pilot, indicating, and spare capacity as indicated.

All outdoor motor starters shall be NEMA 3R, 4X and indoor shall be NEMA 3R, 12 unless otherwise noted on contract drawings.

Auxiliaries: Provide the following auxiliary, function/device for each unit as applicable or as specified on contract drawings:

1. Provide starters with manual start/stop push buttons mounted on the face of the starter enclosure
2. Provide starters with 2 N.O. and 2 N.C. auxiliary contacts
3. Provide starters with Green Lensed “RUN” Pilot Light and Red Lensed “STOP” Pilot Light or lighted start/stop pushbuttons
4. Local Forward/OFF/Reverse selector switch for reversing Combinations Starters.

PART 3--EXECUTION

INSTALLATION:

Install motor starters as listed below:

1. As indicated on the drawings
2. In accordance with the manufacturer's written instructions, the applicable requirements of NEC, and the National Electrical Contractors Association's "Standard of Installation"

3. Complying with recognized industry practices, ensuring that products serve intended functions.

Install heater elements in overload relays. Install and terminate all wiring in starter enclosure. Wiring shall be neatly bundled and supported.

LABELING:

All motor starters shall be labeled. See Section 16195 for Electrical Identification.

FIELD QUALITY CONTROL:

Subcontractor Testing: Tests shall be performed by a NETA certified technician supplied by the Subcontractor or Professional Engineer. Test per NETA 7.16.1.1. The test is to include but not limited to the following:

1. Visual inspection to determine that equipment installation conforms to NEC, these specifications, and the drawings
2. Verify the fuses are sized as specified on the drawings
3. Operate motor to verify correct phase rotation by verifying shaft rotates in the correct direction.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16155

SECTION 16160--PANELBOARDS

PART 1--GENERAL

SUMMARY:

Provide and install distribution and power panelboards of sizes, ratings, materials, and types as shown on the panel schedules. Panelboards shall be equipped with thermal-magnetic, molded case circuit breakers of trip ratings as shown on the panel schedules or as specified on the drawings.

Section Includes, but is not limited to:

Furnish and install the panelboards shown on drawings and specifications including the following:

- Enclosures
- Bus bars
- Breakers
- Covers
- Circuit directories
- Wire labeling.

Terminate all conductors inside enclosures.

Related Sections:

16000 Electrical General Provisions
16195 Electrical Identification
16450 Grounding

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA	Standard of Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	Enclosures for Electrical Equipment (1000 Volts Maximum
NEMA AB 1	Molded Case Circuit Breakers
NEMA ICS 2	Industrial Control Devices, Controllers and Assemblies
NEMA PB 1	Panelboards

NEMA PB 1.1 Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electrical Code (NEC)

UNDERWRITERS LABORATORY

UL 67

SUBMITTALS:

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

NFPA 70
NECA Standard of Installation
NEMA 250
NEMA AB
NEMA ICS 2
NEMA ICS 4
NEMA PB 1
NEMA PB 1.1

PART 2--PRODUCTS

MATERIALS:

Bussing Assembly and Temperature Rise: All bussing shall be copper. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar (NOT to exceed 50° C rise above ambient.) Heat rise tests shall be conducted in accordance with UL Standard 67. The use of conductor dimensions will NOT be accepted as a substitute or replacement of actual heat tests. All panelboards must have ground and neutral bus installed.

Molded Case Circuit Breakers: Circuit breakers shall meet the requirements of Standard NEMA AB 1 with integral thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent,

individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF." Provisions for adding more breakers must NOT require additional connectors.

Integrated Equipment Short Circuit Rating: Each panelboard, as a complete unit, shall have a factory established short circuit current rating equal to, or greater than, the integrated equipment rating shown on the panelboard schedule or on the drawings. This rating shall be established by factory testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per UL Standard 67. The source shall be capable of supplying the specified panelboard short circuit or greater. Factory testing of panelboard overcurrent devices for short circuit rating only while individually mounted is NOT acceptable. In addition, testing of the bus structure by applying a fixed fault to the bus structure alone is NOT acceptable. Panelboards shall be factory marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

Cabinet: Panelboard assembly shall be as specified on the drawings or enclosed in a steel cabinet. The rigidity and gauge of steel shall be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets shall be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. End walls shall be removable. Finish shall be gray-backed enamel electrodeposited over clean phosphatized steel. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door.

Safety Barriers: The panelboard interior assembly shall be dead front with the panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers.

UL Listing: Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. When required, panelboards shall be suitable, and marked in orange letters, for use as service equipment.

PART 3--EXECUTION

INSTALLATION:

Install panelboards as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

Provide electrical connections within enclosures.

Provide filler plates for unused spaces in panelboards. Provide typed circuit directory for each branch circuit, indicating the area and function served by each breaker. Revise directory to reflect circuiting changes required to balance phase loads. Provide engraved nameplates in accordance with Section 16195.

Ground and bond panelboard enclosures according to the NEC and Section 16450. In addition, Article 250.97 shall apply to all panelboards regardless of voltage.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: Visually inspect panelboards to ensure that equipment installation conforms to NEC, these specifications, and the drawings.

Contractor Inspection and Testing: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

CLEANING:

All panelboards, especially those with knockouts removed or holes sawed in the enclosure, shall be thoroughly cleaned and vacuumed to ensure all metal scraps and shreds are removed before the cover is installed.

END OF SECTION 16160

SECTION 16195--ELECTRICAL IDENTIFICATION

PART 1--GENERAL

SUMMARY:

The Subcontractor shall provide and install labels and identification as specified in this document and on the associated drawings. See electrical drawings for equipment identifiers.

Section Includes, but is not limited to:

Install labels on electrical and related equipment, including the following:

1. Wires
2. Cables
3. J-Boxes
4. Switches
5. Receptacles
6. Panels
7. Disconnects
8. MCCs
9. PCCs.

Label major and subfed breakers for MCCs, and PCCs.

Related Sections:

16000 Electrical Sections
16120 Cable, Wire, Connectors and Miscellaneous Devices

REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. See the list of general electrical references in Section 16000.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1 Scheme for the Identification of Piping Systems

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein:

ANSI Standard A13.1 with regard to type and size of lettering for raceway and cable labels

NFPA 70.

PART 2--PRODUCTS

MATERIALS:

Adhesive Marking Labels for Raceway and Metal-Clad Cable: Pre-printed, flexible, self-adhesive labels with legend, identifying system type, or voltage and phase.

Wire and Cable Designation Tape Markers: Self-adhering, oil and moisture resistant, vinyl labels or permanent, irradiated heat-shrinkable polyolefin marker sleeves. Letters shall be typed or printed in black, non-smear ink. Hand lettered labels shall not be used. Engraved identification tags may also be used.

Brass, Steel, or Aluminum Tags: Metal tags with stamped legend and punched holes for fastener. Dimensions: minimum 2-in. x 2-in. x 19 gauge with 1/4-in. radius corners and 3/16-in. hole for fastener.

Brass and Steel Labels: Black engraving and 3/16-in. holes punched in corners. Dimensions: 0.31 to 0.50 inches thick with 1/4-in. radius corners.

Engraved, Plastic-Laminated Labels, Tags, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-in. minimum thick for signs up to 20 sq. in., or 8 inches in length; 1/8-in. thick for larger sizes. Engraved legend and punched for mechanical fasteners.

Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, pre-printed cellulose acetate, butyrate signs with 20 gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide 1/4-in. grommets in corners for mounting.

Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 6/32 galvanized steel machine screws with nuts, flat washers, and lock washers. Signs and labels shall be glued in place using clean GE Silicone II adhesive. Duplex receptacles and light switches shall be glued on only. Labels larger than 1-in. high x 2-in. long shall be glued and screwed on.

LABEL MAKEUP, CONTENT, SIZE, AND LETTERING:

Labels for Electrical Equipment:

General: Labels are to be made from materials that are compatible with the application. Brass or stainless steel shall be used when indicated on the drawings.

Equipment Label Content: Include the following, as applicable, on electrical power-distribution equipment labels:

1. Properly assigned identifier (as shown on drawings) or supplied list
2. Noun name or function description
3. Designation on system designator as assigned by INTEC (See Reference drawing.)
4. Equipment inventory number
5. Voltage and the number of phases
6. Power source (fed from) equipment identifier
7. Circuit number (if applicable)
8. Building in which power source is located (if different from equipment location.)
9. Transformer and disconnect switch labels shall contain the destination (fed to) power equipment identifier fed by the transformer secondary or disconnect switch.

Example Panel Labels:

S-LP-WL-3901
LIGHTING PANEL, 480/277V, 3 PHASE
FED FROM: PANEL EP-2, CKT 2, WMF-603

N-PP-WL-3901
POWER PANEL, 480/277V, 3 PHASE
FED FROM: TRANSFORMER N-XFR-3901

Equipment Label Colors: Background and legend colors for electrical equipment labels shall be as specified in Table I below.

Table I. Electrical Equipment Label Colors

Power System Classification	Power System Designator	Background Color	Legend Color
Normal	N	Black	White
Standby	S	Yellow	Black
Emergency	E	White	Red
UPS	U	White	Red
Regulated	R	same as source	same as source
Direct current	DC	Black	White

Equipment Label and Lettering Size: Electrical equipment label and lettering size shall be as specified in Table II. If equipment size constraints make the specified label size impractical, the label and lettering size will be as large as possible for that particular equipment application.

Table II. Electrical Equipment Label Sizes

Table Power Equipment Classification	Label Height (minimum)	Lettering Height First Line	Lettering Height Subsequent Lines
Primary Distribution Equipment	2-1/2 inch	3/4 inch	3/8 inch
Secondary Power Distribution Switches	1 inch	3/8 inch	1/4 inch
Disconnect Switches	1 inch	3/8 inch	1/4 inch
Power Distribution Panels	1 inch	1/2 inch	1/4 inch
Power Distribution Transformers	2 inch	1/2 inch	1/4 inch
PCC/MCC Switchgear Switchboards	2 inch	3/4 inch	3/8 inch
Power Receptacles	3/8 inch	3/16 inch	N/A

Labels for Light Switches and Receptacles: Labels shall be engraved plastic laminate. Labeling and lettering sizes shall be as specified in Table II above. Labeling shall be consistent with subcontract documents.

Example Light Switch and Single Phase Receptacle Label: N-LP-3901 CKT 2, 120V.

Three Phase Receptacles: Three phase power/welding receptacle labels shall include identifier, voltage, source power panel, and circuit number.

Example Three Phase Receptacle Label: N-RCP-3901, 480V
FED FROM: N-PP-3901, CKT 4

Identification and Labels for Circuits, Cables, and Wire: The method of identification shall be as follows:

Panelboard Breakers: Label single-pole breakers with the single-pole space numbers. Label double pole breakers with the first number of the two single spaces they occupy. Label three pole breakers with the first number of the three single spaces they occupy.

For example, a three-pole breaker in spaces 1, 3, and 5 shall be labeled breaker No. 1. A two-pole breaker in spaces 7 and 9 shall be labeled No. 7. A single pole breaker in space 11 shall be labeled No. 11. Install a type written circuit directory in each panel and furnish a copy to the Contractor.

Conductors: Conductor identification shall include the following:

1. Panel identifier
2. Circuit identification number from the panel with the destination equipment identifier
3. Voltage.

Example Conductor Label: A conductor from S-PP-2301, circuit No. 4, to S-DS-3901 would be identified with the identification number S-PP-2301-4/S-DS-3901, 120V.

Conductor Color Coding: Provide color coding for secondary service, feeder, and branch circuit conductors throughout the project's secondary electrical system as specified in Section 16120.

Conduit Labels:

General: Identify conduit with a label attached parallel to or encircling the conduit. The label shall show a legend of the conductor characteristics, including the following:

1. Highest voltage level contained within the conduit
2. AC or DC current
3. Number of phases.

Example Conduit Label: 120V, AC, 1 Ph,.

Label Color: Conduit labels shall be color-coded as specified in Table III below:

Table III: Conduit Label Colors

Power Type	Background Color	Lettering Color
Normal Power	Orange	Black
Standby Power	Yellow	Black
Emergency Power	White	Red

Labeling Size and Placement: The minimum letter height for content and identification labels of raceways and conduit shall be as specified in Table IV below. A letter size of at least one half the trade diameter is recommended for conduit. The label shall be as long as required to display the specified information.

Table IV. Conduit Label Sizes

Raceway or Conduit Size (inches)	Minimum Height of Lettering (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
Over 10	3-1/2

Note: Size refers to the nominal diameter for conduit or the width of the raceway or cable tray.

PART 3--EXECUTION

INSTALLATION:

General: Install Equipment/System Circuit/Device identification as follows:

Apply equipment identification labels of engraved plastic-laminate on electrical equipment, including the central or master unit of each electrical system and each sub breaker or controller. This includes medium and low-voltage power distribution/communication/signal/alarm systems. Match the text to terminology and numbering of the subcontract documents and shop drawings. Apply labels for each unit of the categories of electrical work listed below:

1. Panelboards, electrical cabinets, and enclosures
2. Motor starters and MCC main cabinets
3. Control devices
4. Components, wires and cables
5. Receptacles
6. Light switches
7. Light fixtures
8. Power Control Centers (PCC) and each sub breaker.

Apply circuit/control/item designation labels of engraved plastic laminate for items listed below:

1. Disconnect switches
2. Breakers

3. Motor controllers
4. Motor control centers
5. Substation and load centers
6. Similar items for power distribution and control components listed above.

For panelboards, provide and install a framed and typed circuit schedule (directory) with explicit description and identification of items controlled by each individual breaker. Furnish a copy of the panel directory to the Contractor.

Install labels at indicated locations as well as convenient viewing locations, free of obstructions and interference from operations and maintenance equipment.

Sequence of Work: If identification is to be applied to surfaces that require a finish, then install identification after the finish work is completed.

Identification and Labeling of Electrical Equipment: Attach equipment label(s) on the front of electrical equipment in as visible a location as possible. Use separate labels to identify cautions or dangers required by code and as designated on the drawings.

Labeling of Light Switches and Receptacles: Light switches and single-phase receptacles shall be labeled to identify the source power panel, circuit number, and voltage. Attach labels securely on or at each receptacle. Use construction adhesive GE Silicone II to glue labels to the cover.

Identification and Labeling of Circuits, Cables, and Wire: Each individual circuit breaker in a panelboard shall clearly identified by a circuit number appropriate to the individual panelboard. Identify circuits, breakers, or spaces that are spare, blank, or utilized for power distribution on the panel legend provided by the Subcontractor or manufacturer.

Conductors to 120V light switches and 120V duplex receptacles do NOT need to be labeled.

Label individual switchgear cubicles/cells.

Each conductor or cable shall be clearly identified and labeled in electrical pull boxes, cabinets or junction boxes. Engraved, laminated plastic identification tags are acceptable for this purpose when attached to each conductor. Attach label or wire marker per manufacturers written instructions.

Label exposed cables used for power distribution or instrumentation with the assigned identification number no less than every 100-ft for the total length of the cable. Individual conductors used for overhead power distribution shall be labeled at each termination point.

If field applied conductor color-coding is used, apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6-in. from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding.

Use 1-in. wide tape in colors as specified. Apply yellow phase tape consisting of two separate bands at each application point to avoid confusion with white, gray, or orange after aging. Do NOT obliterate or obstruct any cable identification markings when taping. Adjust tape locations slightly to prevent such visual obstructions. All phase tape shall be covered by clear heat shrink sleeving.

Conduit Labeling: Exposed raceways and conduits shall be labeled within 3-ft of the power source and adjacent to process equipment; adjacent to each side of any penetration through floors, walls, or bulkheads. Place labels at intervals NOT to exceed 20-ft on straight runs of conduit.

Raceways and conduit shall be labeled at least once in each room through which they pass. For ease of identification, apply labels in a convenient and obvious location. Raceways and conduit in conduction ceiling space above suspended ceilings shall be labeled.

Warning, Caution and Instruction Signs: Install warning, caution, and instruction signs as follows:

1. Where required by NEC
2. As indicated on the drawings
3. Where required to assure safe operations and maintenance of electrical systems and of the items to which they connect
4. Engraved plastic-laminated instruction signs displaying instructions, explanations, cautions, dangers, or warnings personnel may need for the safe operation of the specific system or equipment being operated
5. Butyrate signs with metal backing for outdoor locations.

Identify Junction and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, pre-printed on orange background. Attach labels on the outside of the box cover. Mount an engraved plastic laminate label, identifying the circuits contained in the box, to the box cover. For exposed locations, use pressure-sensitive plastic labels. Use similar labels and tags for concealed boxes.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform the following tests:

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16195

SECTION 16414--MEDIUM AND HIGH VOLTAGE POLE HARDWARE AND EQUIPMENT

PART 1--GENERAL

SUMMARY:

The Subcontractor shall furnish and install, line hardware, insulators, and pole line equipment to make complete and operational distribution line.

Section Includes: Work includes but is not limited to:

Provide and install line hardware, insulators, and other line equipment as shown on the contract drawings.

Related Sections: See other related sections for specific cables, wire, labels, and testing requirements.

16000 Electrical General Provisions
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this specification to the extent designated. Unless otherwise indicated, use the latest edition in effect as of the date of this specification.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

C2 National Electrical Safety Code (NESC)
O5.1 American National Standard for Wood Poles – Specification and dimensions

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

A 153 Zinc Coating (Hot Dip) on Iron and Steel Hardware
A 475 Zinc Coated Steel Strand Wire
B 3 Soft or Annealed Copper Wire

RURAL UTILITIES SERVICE (RUS)

1728H-701 REA Specification for Wood Cross Arms (Solid and Laminated), Transmission Timbers and Pole Keys

SUBMITTALS:

None required for this section.

PART 2--PRODUCTS

Crossarms: Crossarms shall be Douglas fir and meet the requirements of REA bulletin 1728H-701.

Conductor: Primary conductors shall be #4 copperweld.

Ties and Grips: Side ties and top ties shall be Performed Line Products.

Strain Clamps: Dead End strain clamps shall be Anderson.

Crossarm Brace: Crossarm braces shall be Chance 6953.

Pole Bands: Pole bands shall be Hubbell/Chance C203-0194 type, with C203-0183 connecting links.

Equipment Mounts: Mount for cutouts and lightning arrestors shall be Aluma-Form # R3CA. Mount for 15kV cable shall be Aluma-Form #TB-EMB-1-6PA with 3M MB-3 #80-6108-3129-1 mounting brackets.

Cut-outs: Fused cutouts shall be ABB type LBU-II 15kV, 100 Amp load break, 100 continuous Amps model #279C790A11. Fuse links shall be as indicated on the drawings. Non- fused cutouts shall be ABB type LBU-II 15kV, 300 Amp, solid blade, load break, model #279C790A14.

Ground Rod: Ground rod shall be 5/8-in. diameter and 8 ft. long copper clad steel.

Miscellaneous Hardware: Other hardware not specifically addressed shall be RUS approved. Installation hardware such as bolts; washers, locknuts, spring clips and etc shall be used as shown in REA D-804.

PART 3--EXECUTION

INSTALLATION:

Materials and equipment shall be installed in accordance with the requirements of the National Electrical Safety Code (NESC), ANSI/IEEE Standard 524, manufacturer's written recommendations, NECA Standard of Installation, and in accordance with recognized industry practices to insure products serve intended functions.

Insulators: Insulators shall be handled with care to avoid damaging the galvanizing or chipping or cracking the porcelain. After installation, insulators shall be free of grit and dirt, which could be a problem during subsequent operation.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The following inspections, test and reports shall be made prior to contractor acceptance of work conducted under this subcontract:

1. Material and devices shall be inspected prior to and after installation to verify that they are the quality and type required by subcontract specification and drawings, free of damage and that they have been properly installed
2. Visual inspections to determine that all electrical connections are properly made
3. Provide inspection reports for all inspections performed.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16414

SECTION 16450--GROUNDING

PART 1--GENERAL

SUMMARY:

Section Includes, but is not limited to:

Subcontractor shall provide and install grounding of sizes, ratings, materials and types as shown on the drawings and as recommended by the NEC and the NESC.

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. Unless otherwise indicated use the latest edition in effect as of the date of these specifications.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electrical Code (NEC)

AMERICAN NATIONAL STANDARDS ASSOCIATION (ANSI)

ANSI C2 National Electrical Safety Code (NESC)

SUBMITTALS:

None required for this section.

PART 2--PRODUCTS

MATERIALS:

Equipment grounding conductors shall be green insulated or bare copper, sized and located as shown on the drawings. Use field-applied, green tape for insulated conductors in accordance with Section 16195--Electrical Identification.

Grounding rods shall be a minimum of 5/8 in. diameter and 8 ft long copper clad steel.

Grounding grid connections below grade shall be made by the exothermic welding process or listed nonreversible compression fittings.

Exothermic welds shall be Cadweld.

Non-reversible compression fittings shall be Burndy HyGround.

PART 3--EXECUTION

INSTALLATION:

Install a complete grounding system as indicated on the drawings in accordance with applicable requirements of the NEC, the NESC, and complying with recognized industry practices to ensure that products serve intended functions and comply with requirements.

All exposed noncurrent-carrying metallic parts of electrical equipment, raceway systems and the neutral conductor of the wiring system shall be grounded.

Beam or compression type grounding clamps shall be used for all above grade grounding attachments to building steel. Exothermic welds to structural steel shall not be allowed.

All conduit (except spares) shall contain a dedicated equipment-grounding conductor.

Conduit shall not be used as the equipment-grounding conductor.

Grounding rods shall be driven so that the top of the rod is 1 ft. below finish grade.

Non-reversible Compression Connections: Connections shall be made in accordance with manufacturer's written recommendation.

Exothermic Welds: Exothermic welds shall be made in accordance with the manufacturer's written recommendations.

FIELD QUALITY CONTROL:

Site Tests: The Subcontractor or his agents shall perform visual inspections to determine that the grounding installation conforms to the NEC, these specifications, and the drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16450

SECTION 16462--TRANSFORMERS, PAD MOUNTED, LIQUID FILLED, POWER

PART 1--GENERAL

SUMMARY:

Subcontractor shall provide transformers of sizes, ratings, and types as shown or listed on the drawings.

The Subcontractor shall install the transformers in the approximate locations shown, provide the transformer pads, and comply with all provisions of the NEC and NESC as to clearances, grounding, location, local disconnects, and NEMA ratings.

Related Sections:

16110 Electrical Raceways
16120 Cable, Wire, Connectors, and Miscellaneous Devices
16124 Insulated Medium Voltage Cable and Connectors
16195 Electrical Identification
16450 Grounding

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI-C57.12.00	Standard General Requirements for Liquid Immersed, Distribution, Power, and Regulating Transformers
ANSI-C57.12.26	Standard for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors (34 500 Grd Y/19 920 V and Below) 2500 kVA and Smaller
ANSI-C57 12.70	Terminal Markings and Connections for Distribution and Power Transformers
ANSI-C57.12.80	Terminology for Power and Distribution Transformers
ANSI-C57.12.90	Test Code for Liquid Immersed Distribution, Power and Regulation Transformers
ANSI-C57.12.98	Guide for Transformer Impulse Tests
ANSI Z55.1	Gray Finishes For Industrial Apparatus & Equipment

FACTORY MUTUAL

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA TRI-1974 Transformers, Regulators and Reactors

NATIONAL ELECTRICAL TESTING ASSOCIATION

UNDERWRITERS' LABORATORIES, INC. (UL)

UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

SUBMITTALS:

Product Data: Include data on features, components, ratings, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

Test Reports: Test results for tests specified in Part 2.

Refer to Section 01300, Submittals and the Vendor Data Schedule for additional requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

NFPA 70 National Electrical Code (NEC)

PART 2--PRODUCTS

The transformers shall have the following ratings:

KVA 750, OA, [OA/FA], [OA/FA/FOA]
Impedance 5.75%
HV 13800 kV Delta
LV 480Y/277 Volts Wye
BIL HV 95 KV
HV Taps 12000, 12470, 13200, 13800, 14400.

TECHNICAL REQUIREMENTS:

The transformers shall be compartmental type, self-cooled, tamperproof, and weatherproof for mounting on a pad and shall comply with latest applicable standards of the National Electrical Manufacturers Association (NEMA) and the American National Standards

Institute (ANSI). There shall be no exposed screws, bolts or other fastening devices that are externally removable.

The transformers shall carry a continuous rating with average winding temperature rise by resistance that shall not exceed **65° C**, based on average ambient of 30° C over 24 hours with a maximum of 40° C. The insulation system shall allow an additional 12% kVA output at 65° C average winding temperature rise by resistance, on a continuous basis, without any decrease in normal transformer life.

The transformers shall be filled with a liquid **mineral oil**. The liquid shall meet all applicable UL, FM, and NEC requirements.

The transformers shall be designed to carry short time emergency overloads in accordance with ANSI C57.12.90 as applicable. Duration and magnitude of designed withstand capability shall be as outlined in ANSI C57.12.90 and the latest draft of the IEEE Short Circuit Test Code.

The transformers shall be designed to meet the sound level standards for liquid transformers as defined in NEMA TR1.

The transformers shall be of sealed tank construction of sufficient strength to withstand a minimum pressure of 7 psi without permanent distortion. The transformers and attached components shall be designed to withstand pressures 25% greater than the required operating design value without permanent deformation. The covers shall be welded and the fastenings tamperproof. The transformers shall remain effectively sealed for a liquid temperature range of 50° C to 106° C. **Cooling panels shall be provided on the back and sides of the tank.**

Lifting eyes shall be provided.

The transformers shall be of Delta/Grounded Wye construction.

The enclosure shall be cleaned, phosphatized, primed and finished with a weather resistant coating. The unit shall be painted using the manufacturers standard paint process baked on to a minimum of three mils average thickness. Units shall be painted ANSI 61 for outdoor use.

HIGH VOLTAGE TERMINATIONS AND EQUIPMENT:

The high voltage terminations and equipment shall be Dead Front and conform to ANSI C57.12.26 requirements.

Dead Front bushings shall be one piece integrated type for use with elbow terminators and shall be externally clamped.

HIGH VOLTAGE EQUIPMENT:

Provide three distribution class, metal oxide, gapless, lightning arresters sized for the transformer rating and mounted in the high voltage compartment for lightning or switching surge protection.

LOW VOLTAGE TERMINATIONS AND EQUIPMENT:

The low voltage bushings shall be molded epoxy and provided with blade type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing grounded to the transformer tank by a removable grounding strap.

Nameplate data and listing visible on low voltage compartment.

1 in. upper filter press connection and filling plug.

1 in. drain valve with sampling device 750 KVA.

Dial type thermometer.

Liquid level gauge.

Pressure relief device (self resealing with indicator).

De-energized tap changer.

Provisions for lifting [optional accessories].

Primary fuses.

Primary disconnect switch.

PART 3--EXECUTION

INSTALLATION:

Install transformers as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of the NEC and the National Electrical Contractors Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

Labeling: For labeling requirements see Section 16195--Electrical Identification.

GROUNDING:

Ground the transformer per manufacturer's recommendation, the NEC, and contract drawings.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: The Subcontractor shall develop a construction component (CC) test procedure and format for test documentation, which shall be submitted to Contractor for review and approval. Testing shall be per applicable NETA section. Subcontractor shall submit a completed test report.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify that equipment installation conforms to the NEC, these specifications and the Contract drawings.

END OF SECTION 16462

SECTION 16810--INSTRUMENTATION

PART 1--GENERAL

SUMMARY:

This section includes process measurement; primary elements, indicators, control, and twisted-pair cables, connectors, and terminal equipment.

Section Includes but is not limited to the following:

Install the Subcontractor-supplied instrumentation and related equipment, wiring and cabling as shown on the drawings and specifications including the following:

1. Level indicators
2. Level Transmitters
3. High level transmitters
4. High level control
5. High level alarm
6. Interconnecting wiring
7. Assembly and internal connections as required.

Related Sections:

16000 Electrical General Provisions
16110 Electrical Raceways
16120 Cable, Wire, Connectors and Miscellaneous Devices
16195 Electrical Identification

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
NEMA ICS 1	General Standards for Industrial Control and Systems

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

INSTRUMENTATION, SYSTEMS AND AUTOMATION SOCIETY (ISA)

ISA 5.1	Instrumentation Symbols and Identification
ISA 50.1	Compatibility of Analog Signals for Electronic Industrial Process Instruments

SUBMITTALS:

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements. Submittals include, but are not limited to the following:

Installer's Certification: The Subcontractor shall submit a certification of the installer's experience required under Quality Control.

Product Data: Vendor data, as required by the Vendor Data Schedule, for materials and equipment to be furnished by the Subcontractor shall be submitted by the Subcontractor for approval. The data submitted shall be in such detail as to clearly illustrate the materials and equipment, including components and the fabrication thereof, that the Subcontractor proposes to furnish.

Equipment and Wire Lists: The Subcontractor shall submit an equipment and wire list for Contractor approval based on label requirements listed.

Wire and Cable Tests: The Subcontractor shall furnish copies of wire and cable test results and reports required in Part 3--Execution.

Government Furnished Material: The Subcontractor shall turn over any documentation packaged with government furnished items.

Operation and Maintenance Manuals: The Subcontractor shall furnish copies of installation, operating and maintenance manuals for new equipment. Such data shall be prepared by the manufacturers of the equipment that is to be furnished and installed under these specifications.

Manuals shall be complete and shall include operating instructions and special test procedures or instructions recommended by the manufacturer, maintenance procedures, a complete parts list and recommended list of spare parts for normal expected maintenance.

QUALITY CONTROL:

Qualifications: Engage Installers with a minimum of three years of documented instrumentation and control installation experience.

Regulatory Requirements, Codes and Standards: Comply with the provisions of the following codes and standards unless otherwise specified herein.

NATIONAL FIRE PROTECTION ASSOCIATION NATIONAL ELECTRICAL CODE (NFPA 70)

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1926	Construction Industry Safety Standards
29 CFR 1910	General Industry Safety Standards

DELIVERY, STORAGE AND HANDLING:

Storage and Protection: Provide site and warehouse storage facilities for equipment.

Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions or have temperature related storage limitations.

Cover panels and other elements that are exposed to dusty construction environments.

Environmental Requirements: Unless noted otherwise, equipment and enclosures shall be rated at least:

- Freestanding Panel
  - Indoors: NEMA 12
  - Outdoors: NEMA 3R, 4, or 4X
- Junction/Pull Boxes
  - Indoors: NEMA 12
  - Outdoors: NEMA 3R, 4, or 4X
- Field Devices
  - Indoors: NEMA 12
  - Outdoors: NEMA 3R, 4, or 4X

Higher levels of protection may be used in place of level specified above. For example, NEMA 12 in place of NEMA 1.

Existing Conditions: Environmental conditions are defined below:

- Inside:
  - Temperature: 40 to 90 degrees F
  - Relative Humidity: 15 to 90 percent non-condensing
  - NEC Classification: Non-hazardous
- Outside:
  - Temperature: -30 to 100 degrees F
  - Relative Humidity: 15 to 90 percent non-condensing
  - NEC Classification: Non-hazardous

Field Measurements: The Subcontractor shall field verify dimensions prior to fabrication.

General: Furnish all labor, materials (except government furnished material), equipment and appliances required to complete the installation of the complete instrumentation systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code NFPA 70 and Occupational Safety and Health Administration (OSHA). All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor. All materials, equipment and installations shall be accessible for inspection by the Contractor

or his designated representative during any phase of construction, fabrication, manufacture and erection or testing.

MANUFACTURERS:

Subject to compliance with requirements, provide products of manufacturers as indicated on the drawings.

Process Measurement And Control Instruments: Level indicator systems as indicated on the drawings.

TWISTED-PAIR CABLES, CONNECTORS, AND TERMINAL EQUIPMENT:

Conductors: Stranded tinned copper.

Twisted-Pair, Shielded Instrument Cable: The cable shall be a Belden #8763, 20 AWG or approved equal.

Connectors and Splices: Factory-fabricated connectors of size, ampacity rating, material, type, and class for application and service indicated. Splices are NOT allowed unless specifically shown on the drawings.

PART 3--EXECUTION

Dimension Verification: The Subcontractor shall field verify dimensions prior to fabrication.

COORDINATION OF INSTRUMENTATION WORK:

General Requirements: Materials and equipment shall be erected or installed only by qualified personnel who are regularly engaged in the trades required to complete the work. The subcontract drawings show the general arrangement and space allocation of the equipment specified. It shall be the Subcontractor's responsibility to verify changes in conditions or rearrangements necessary because of substitutions for specified materials or equipment. Where rearrangements are necessary the Subcontractor shall, before construction or installation, prepare and submit drawings of the proposed rearrangement for approval. The drawings and changes shall be made at no cost to the Contractor.

Workmanship: The Subcontractor shall perform structural cutting, fitting, patching, repairing and associated work necessary for installation of instrumentation, equipment, wiring and electrical conduits. No major cuts or holes, not shown on the drawings, shall be made without prior approval of the Contractor. After the equipment and/or conduit is installed, all exposed holes, cracks and other defects shall be neatly patched and the patched areas shall match the adjoining materials and finish.

Arrange work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance where possible.

Locate operating and control equipment properly to provide easy access, and arrange entire instrumentation work with adequate access for operation and maintenance.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer.

Ensure instruments and electrical equipment are mounted per manufacturer's recommendations using the provided mounting holes, brackets and hardware.

Wiring Methods: Temporary wiring methods as described in Article 527 of NFPA 70 will be allowed on this project unless other wise indicated on the drawings. All wiring and cables must be protected from damage. Wires and cables shall be protected by bushings or fittings where passing through holes in covers, outlet boxes or similar enclosures,

Install cables using techniques, practices, and methods that are consistent with signal rating of components and that ensure signal performance of completed and linked signal paths, end to end.

Install cables without damaging conductors, shield, or jacket. Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.

Pull cables without exceeding cable manufacturer's recommended pulling tensions. Pull cables simultaneously if more than one is being installed in same raceway. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation. Use pulling means, including fish tape, cable, rope, and basket-weave wire or cable grips that will not damage media or raceway.

Wiring within Panel Enclosures: Provide conductors of adequate length. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

New wire in existing control panels and junction boxes shall be routed with existing wire bundles and shall use existing wire ducts where possible. Wiring shall also be separated by voltage. The 120 VAC shall be routed separately from all other circuits. Parallel runs (of 120 VAC and other circuits) shall be separated by at least 3 inches. If it becomes necessary to bring a 120 VAC bundle across a non-120 VAC bundle, the crossing shall be made at a 90 degree angle. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components. Splicing or tapping of wires is not allowed in panels.

Portable power and instrumentation cords shall be separated by at least 2 inches if possible. the crossing of such cables shall be made at a 90 degree angle.

GROUNDING:

Comply with Section 16450--Grounding.

Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

Bond shields and drain conductors to ground at only one point in each circuit. This point is indicated on the drawings.

LABELING:

Equipment Labeling: Install the engraved labels as shown on the drawings. Identifying items with marking pens, adhesive tape, embossed plastic or metal tape, or similar type means is not acceptable.

Labels shall be laminated phenolic or plastic colored black with white engraved letters.

Unless shown otherwise on the drawings equipment mounted outside shall be labeled with a stainless steel tag of a thickness not less than 19 gauge with legend letters not less than ¼ inch tall.

If not shown on the drawings equipment nametags shall be installed by one of the following means:

1. Hung off equipment with 1/16 inch stainless steel bead chain or cable
2. If inside, attached to equipment or immediately next to equipment using a suitable adhesive such as General Electric RTV silicone rubber. They may also be attached to equipment or immediately next to equipment using bolts, screws or rivets
3. If outside, attached to equipment or immediately next to equipment using bolts, screws or rivets.

Wire Labeling: All conductors or cables shall be identified with white heat shrink tubing with black typed on minimum 3/32 inch letters with non-smear ink such as Brady-321, Brady-322 or approved equal. Hand lettered labels shall not be used. All conductors or cables shall be labeled with point-to-point destination. Wire label legends shall follow an origin/destination practice. For example consider a single conductor between terminal 8 on TB9 in CP-YDJ-963 and Terminal A on instrument FSL-YDJ-3. At CP-YDJ-963 the label would be 8/ FSL-YDJ-3-A and at FSL-YDJ-3 the label would be A/CP-YDJ-963-TB9-8. If legend length would exceed label length it is acceptable to drop the sub area (YDJ), if used, from the legend.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform the following on-site tests:

Electrical Continuity: After conductor connectors are installed and conductors are labeled, but prior to termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding and other conductors are properly installed and identified. The Subcontractor shall provide the Test Data Submittal Sheets. List all conductors tested on required test data submittal sheets.

Electrical Meggering: Prior to terminating, test cable or wire of 25 ft or longer for insulation resistance with megger (500 V megger for 300 V insulation and 1000 V megger for 600 V insulation). Any wire with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating. The Subcontractor shall provide the Test Data Submittal Sheets. List conductors tested on required test data submittal sheet.

Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

Contractor Inspection and Testing: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications. All equipment (except GFE) shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

END OF SECTION 16810